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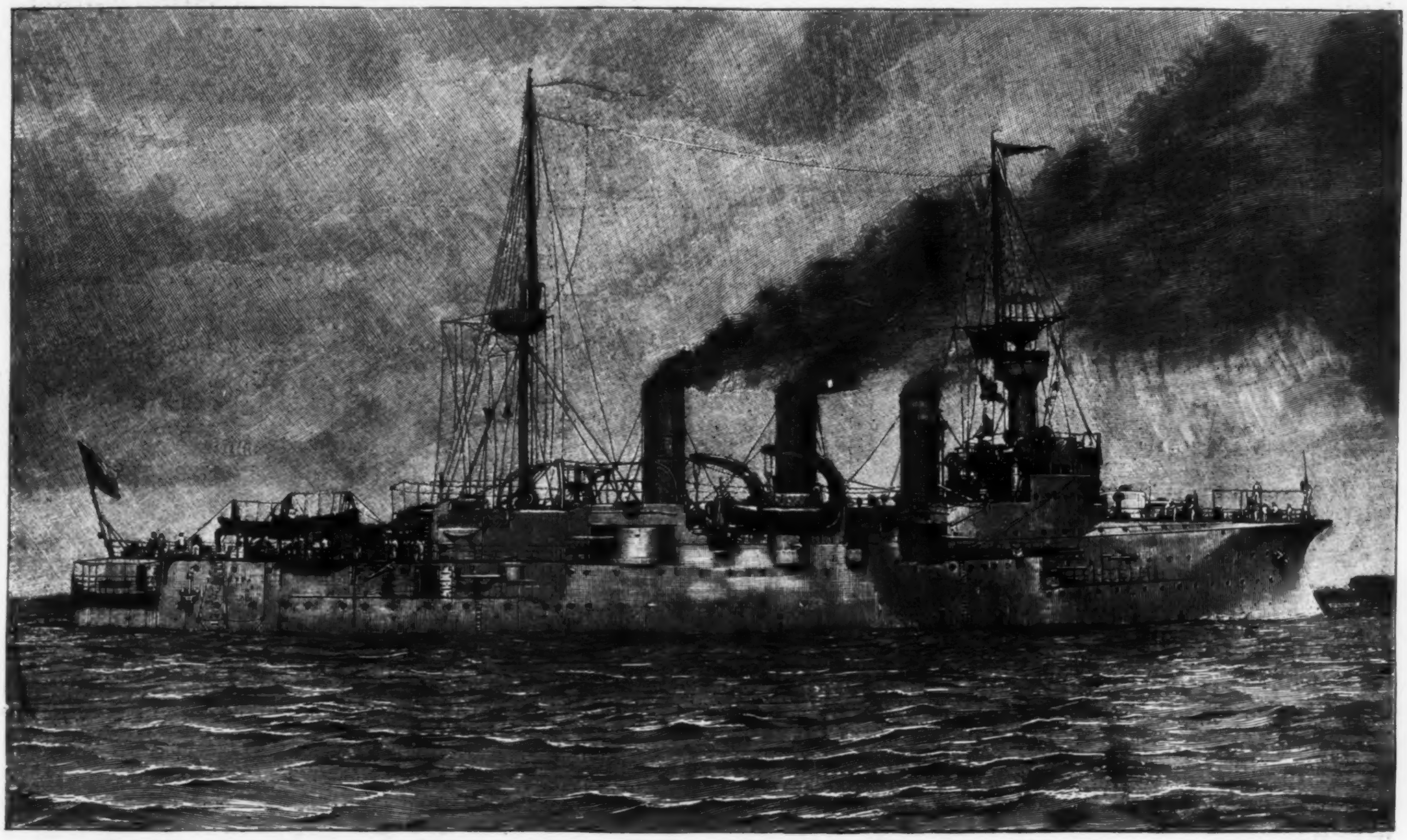
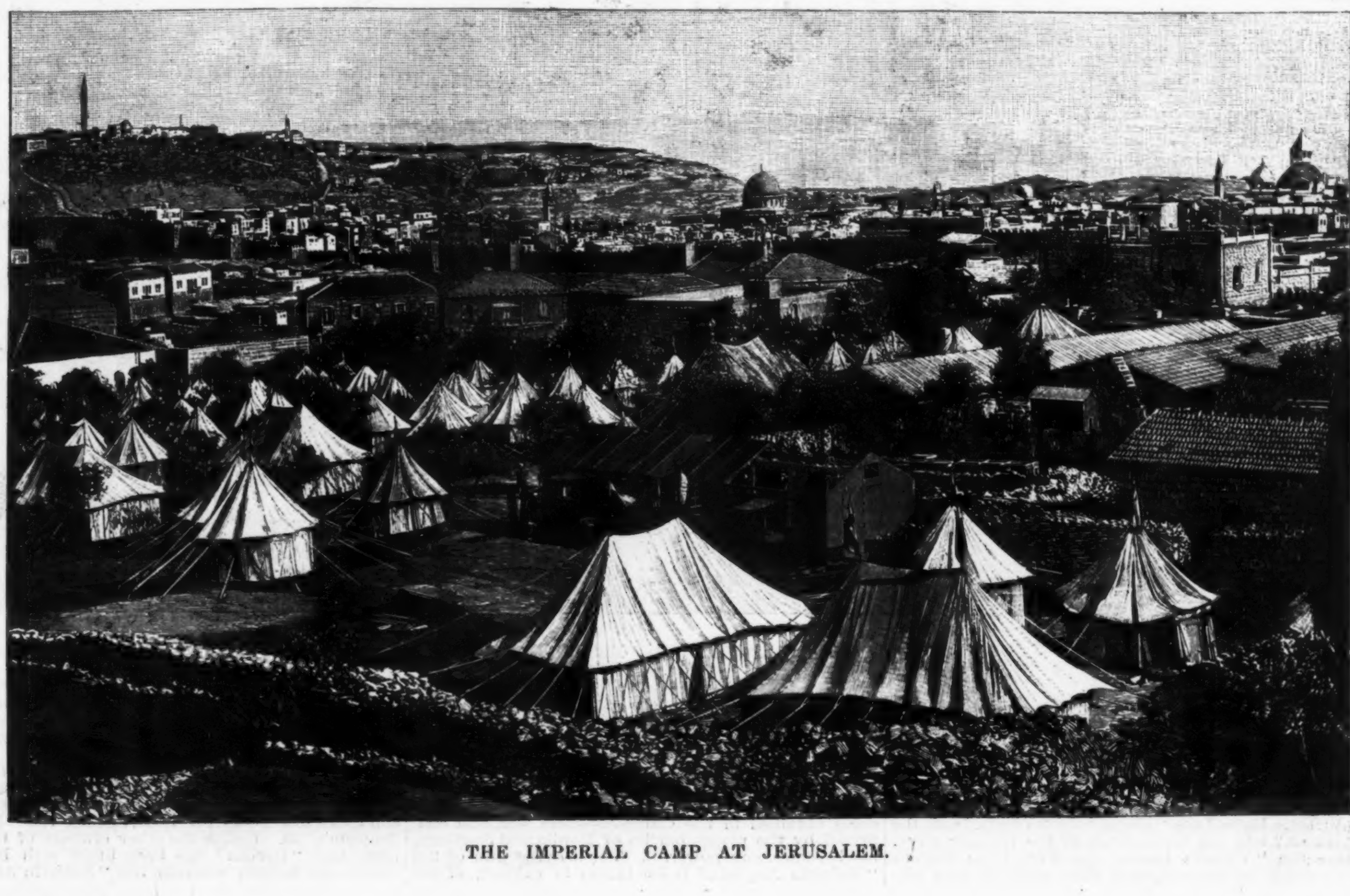


THE GERMAN CRUISER "HERTHA." WHICH ACCOMPANIED THE EMPEROR ON THE JOURNEY TO THE HOLY LAND.

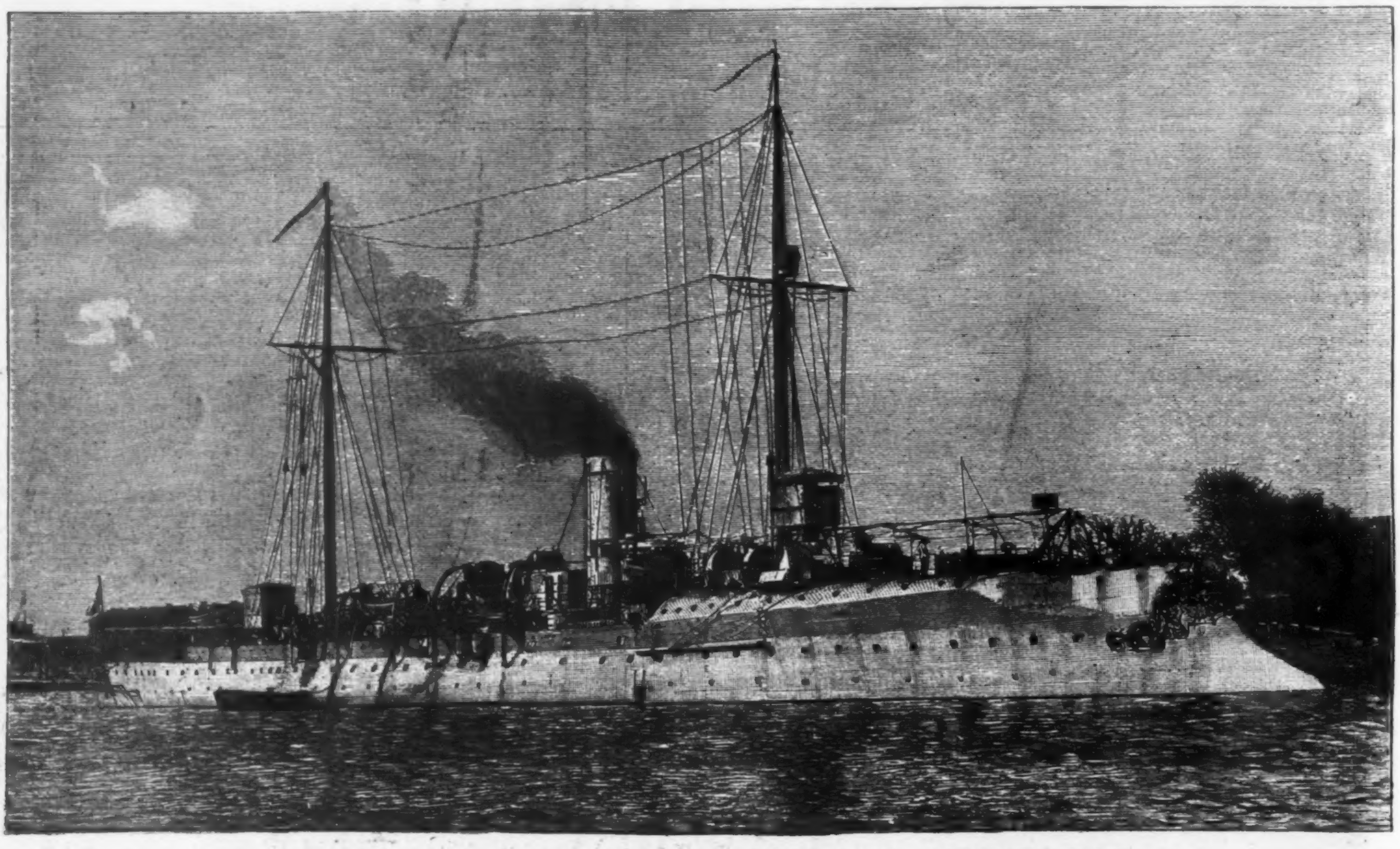


THE IMPERIAL CAMP AT JERUSALEM.

THE KAISER'S PILGRIMAGE TO THE HOLY LAND.

The oriental tour of the Kaiser is about to be completed. So far as the voyage itself was concerned, the Kaiser used his yacht "Hohenzollern," described in Supplement 1194. Since the invited guests could not all find accommodations on board the imperial yacht, Germany's two newest warships—the cruiser "Hertha" and the scout-boat "Hela"—were called into service. Painted a snowy white, these vessels almost equal in appearance the imperial yacht.

While the "Hohenzollern" and "Hela" have already made long voyages, the keel of the "Hertha" for the first time plowed the sea on this tour of the Kaiser. She is, says the Illustrirte Zeitung, a new cruiser of a type which, with the exception of the "Victoria Luise," the "Freya," the "Vineta," and the "Hansa," was not represented in the German navy. Save the "Victoria Luise," named after the Kaiser's only daughter, the designs of these cruisers were borrowed from the former Prussian navy. Of these five new ships, the "Hertha," built at the Vulcan docks, near Stettin, is the only one completed. Two additional cruisers may, however, be finished within the present year. In these vessels the German navy will receive a valuable addition; for, during the last six years, no new cruisers have been added to the fleet. This remarkable neglect is explained by the unintelligible averseness of the Reichstag from meeting even the most modest demands of the Admiralty, as well as by the great strides made in the fields of naval architecture and of ordnance. How great this progress has been, especially in recent times, can be well shown by comparing Germany's two newest cruisers, the "Kaiserin Augusta," now forming part of the Asiatic fleet, and the "Hertha."



THE GERMAN AVISO "HELA," WHICH ACCOMPANIED THE EMPEROR'S FLEET.

A VIEW OF BETHANY.

First of all, the armament, as a result of the experiences obtained in the Chino-Japanese war, and confirmed by the recent battles of Manila and Santiago, has become more powerful. The heaviest gun of the "Kaiserin Augusta" is 5·9 inches in caliber; of the "Hertha," 8·2 inches in caliber. The number of rapid-firing guns on the "Hertha" is also greater. The "Kaiserin Augusta" carries only twelve guns of 5·9 inch caliber, eight rapid-firing guns of 3·4-inch caliber, eight machine guns, two light pieces, and five torpedo tubes. The "Hertha," on the other hand, carries two 8·2-inch rapid-firing guns, eight 6-inch, ten 3·4-inch, ten 1·4-inch, four machine guns, and three torpedo tubes.

The armor, as well as the armament, has also been improved. The guns of the "Hertha" are mounted in armored turrets, and behind casemates of 4-inch Harvey steel. The conning tower and the ammunition hoists are similarly armored. The deck is protected by 4-inch Harvey steel.

The engines of the "Hertha," at a total displacement of 5,628 tons, are not so powerful as those of the "Kaiserin Augusta;" but with 10,000 horse power she can make 18½ knots per hour, against the "Kaiserin Augusta's" 20. Unlike the other cruisers of the same type, the "Hertha" has been fitted with Belleville water-tube boilers, whereas the "Kaiserin Augusta"

has been provided with locomotive boilers. The crew of the "Hertha" numbers 439 men.

The remaining vessel of the Kaiser's fleet, the "Hela," is the latest and probably the last scout-boat of the Imperial navy; for in the future, Germany will build no more vessels of this type. The "Hela" was constructed by the Wefer Company, of Bremen, and was launched in 1895. After having successfully completed her trials, she began her first voyage in the past summer as part of the squadron which accompanied the Kaiser to Norway. Her displacement of 2,000 tons, length of 328 feet, beam of 36 feet, give her an unusually slender appearance. Her speed of over 20 knots per hour, obtained with engines of 6,000 horse power, compares favorably with that of the large ocean steamers. Requiring but a light armament, the "Hela" has been provided with four 3·4-inch rapid-firing guns, six 1·9-inch and two machine guns. The "Hela" is the first scout-boat to be provided with a thin protective deck. The cruising radius of the "Hela" is comparatively large, for the vessel may be compelled to steam many miles without being able to touch at any port. The complement of the "Hela" is 187 men. After her return from the Orient, the "Hela" will take her place in the Brandenburg division.

With these vessels the Kaiser voyaged to the Orient. Of his subsequent journey to Jerusalem, of the consecration of the church of the Saviour, we have already spoken at length in the SUPPLEMENT already referred to. In addition to the illustrations already published, we have here reproduced from the Illustrirte Zeitung several engravings of noteworthy spots in Palestine, which were visited by the Kaiser.

The road to Jericho leads to Bethany, a town situated on a slope and surrounded by olive trees. Here may be seen the houses of Martha and of Simon and the tomb of Lazarus. Thence the road passes over ranges of bald mountains, down into the valley of the Jordan, on the borders of which, not far from the spot (Quarantine Hill) on which, according to tradition, Christ fasted for forty days, there lies a wretched village, which now marks the site of the Jericho of old.

The monastery of Mar Saba is best reached from Jerusalem by traveling up the valley of the Kedron through a number of fantastic ravines in which nomadic Bedouin tribes are wont to set up their tents. As early as the fifth century, St. Euthymius here consecrated a monastery, which became a place of importance under his disciple Saba. Later the monastery was several times destroyed, but was restored by the Russians in 1840, and now serves as a kind of exile for delinquent priests of the Greek church. The monastery lies in a dreary desert, and is built on a number of terraces, the lowermost of which has a slope of 650 feet. In the overlying heights hyenas and jackals now dwell in the ruined houses of former monks.

Let us now return to Jerusalem and glance at the city of Zion. Assuredly the city shines no longer in the glory bewept by Christ on the Mount of Olives. Passing out of the city on the road to Jaffa, there is seen in the distance Mount Carmel, the mountain of God, upon which Elijah of old prayed for the fire of Jehovah to consume his sacrifice, and thus caused Ahab to exterminate the prophets of Baal, who were unable to call down fire to consume their offerings.

From Jaffa to Haifa, in the Bay of Akka, where the Kaiser landed upon holy ground, is a journey of eight hours by water. Viewed from a distance, the town presents the appearance of a European city. As a matter of fact, the city owes this character to the Württemberg colonists who have settled there.

From Haifa the road leads to Nazareth, where many a spot of interest may be visited. Nazareth was always an insignificant place, and only during the period of the crusades, when it became an archiepiscopal see, was it of any importance.

On October 29 the brilliant retinue of the Kaiser arrived at the imperial encampment before the walls of Jerusalem. On the same day the Kaiser passed through the Jaffa gate into the Holy City. The imperial camp was situated in a grove in an easterly direction from the Abyssinian church. Looking toward the east, one could see the Holy City, and in the distance the Mount of Olives, upon which stand the church of the Ascension, and the slender tower built by the Russians. The confused mass of houses was overtopped by the belfry of the new church of the Saviour and the dome of the Sepulcher. In the distance rose the mosque of El Aksa and the dome of the mosque of Omar. Toward the west were situated the tents of the Kaiser and Kaiserin.

Each tent included living, sleeping, and bath rooms. Connected with the tents were a large eating tent and three smaller tents, serving as reception and smoking rooms. Before the imperial tents extended a board walk covered with mats. In an easterly direction were situated the orchestra tent, and three rows of round tents for the use of the higher dignitaries; removed from the latter a short distance were six rows of tents for the servants. In a villa in the southeastern portion of the grove the telegraph operators were stationed and the body guard of the Kaiser were quartered. Not far from the villa the stables for the horses and tents for the grooms were erected. To the south a road led to the Jaffa gate, through which the Kaiser passed in his triumphal entrance into the city.

Tainted meat can be sweetened and purified by the use of charcoal.

THE MONASTERY OF MAR SABA.

NUT GROWING INCREASING.

THE local nutting season round about New York begins early in October and continues well up to the Christmas holidays, and the farmers' boys and Italian residents of the city are kept busy gathering the chestnuts, black walnuts, butternuts, and hickorynuts in the woods north of us, across the river in New Jersey, and on Long Island. The commercial nutting business is assuming greater proportions every year in this country, and the farmers are planting nut trees for profit along with their apple, peach, pear, and plum trees. A nut orchard properly attended to frequently yields as much profit as an orchard of peaches or apples, and the trees can be made to grow on the sides of hills that can be utilized for little else. In New England the bleak, stony hillsides of farms that were considered of little real agricultural value are being successfully planted with walnut trees, chestnuts, butternuts, and other nut-bearing growths. In the West and Southwest land that is too wet for corn, wheat, and other cereals is utilized for raising hickory and pecan nuts. The latter, in particular, will thrive on land that is frequently flooded with water, and in a wild state the trees are mostly found growing on rich alluvial bottoms along the streams of fresh water.

California started into nut culture on a large scale first, and the example she set has been followed by most of the other States. To-day she produces more than two million pounds of English walnuts, great quantities of almonds, improved chestnuts, English filberts, and hazelnuts. In the South the pecan trees have been growing for half a century in a semi-wild state, but for ten years now groves of them have been planted and cultivated by the farmers with every promise of success.

The question of nut growing for profit was agitated in this country about ten years ago. At that time our importations of nuts were heavy, amounting to many millions of pounds. They came from England, Madeira, Spain, Portugal, Persia, and many other countries of Europe and Asia. Our few wild trees were neglected and their fruit ungathered by the farmers except for their own private use. It was not thought then that the nuts could prove of much commercial value. The farmers' boys and the Italian venders gathered a small crop every autumn and sold them to the stores in the city for a nominal price. Our chestnuts were the most important, and a large crop of these always found a market in the local towns and cities.

But in ten years now a new industry has sprung up and developed into one of considerable commercial importance. Not only has the market been supplied with home-grown nuts, but a wider demand for them

has been created. The hygienic value of nuts is better understood and appreciated to-day, and the consumption of them has steadily increased in this country. They are used in an endless number of ways in our modern cooking and confectionery. Certain varieties yield a valuable oil, such as the pecans, which is used by clockmakers and gunsmiths and also for table purposes.

The improvement in nut culture began with the introduction of foreign chestnuts. Our native chestnut is practically one species, but there are several other species and varieties found abroad. The European chestnuts are larger than ours, but they are inferior in quality to the wild American chestnuts. A few species of Japanese chestnuts are not only larger, but superior in flavor to both. Each species was found to have its drawback. The American chestnuts were hardy, sweet, delicious, and prolific, but small; the European species were large and attractive, and the trees came into bearing in about half the time required for the American, but the nuts were inferior in flavor, and the Japanese species were large, quick-bearing, and rich in juicy meat, but the trees were dwarf in habit and not perfectly hardy.

The question for the pomologist to decide was how to combine these various good qualities of the several species into one and eliminate the inferior points from the cross. This has been obtained by selecting good American chestnut trees for the stock, and working on them the best Japanese species. The result is that a hardy, prolific, early-bearing tree has been produced, with large, delicious nuts on it that equal any imported from abroad. They are sold in the market as Japanese chestnuts. Some of them are the genuine Japanese nuts from the South and California, where the dwarf trees can endure the climate. But the Japanese and European chestnuts raised in the Middle, Eastern, and Western States are nearly all from grafted or budded native stock. Some remarkable stories are told of the size and quality of these improved Japanese chestnuts; but after making allowances for exaggeration, there is still enough left to cause one to marvel at the success of scientific nut growing. All chestnuts come into bearing earlier by transplanting and cultivation, and all the trees started in orchards are nursery grown. The Japanese trees come into bearing as early as the peach, and when grafted on native stock they are nearly as early. The burrs open without the aid of frost, and the nuts are on the market long before frost appears.

English walnuts have been found to do well in Indiana, New Jersey, and New York, and good crops have been gathered every year for ten years past in several orchards. England imports 150,000 trees from the Continent annually, and we have heretofore drawn heavily upon Europe for our supply. The trees are rather tender, and are likely to be injured by our cold winters unless protected for the first few years of their growth. After that they seem to do well in our cold climate. In the South and on the Pacific coast they are not affected unfavorably by the climate, and the trees yield abundant crops.

Next to the chestnuts, the pecans are probably the greatest of American nuts that are raised and used quite universally in most of the States of the Union. Primarily found growing chiefly in the States south of New York, their line of culture has been gradually extended to all parts of the North. They produce larger crops, however, in the South. In Illinois a native pecan tree is found which is said to be as hardy as the apple and fully as prolific of nuts as the Southern trees. Even in Michigan pecan trees are now found. In their wild state the trees are slow of growth and come into bearing only after a lapse of ten, fifteen, and twenty years. But those cultivated in orchards produce a bushel of nuts in ten years from the planting of the seed, and the crop increases gradually every year thereafter. So important has pecan culture become in parts of the South and West, that nurserymen make a specialty of raising the trees from seeds, and a beginner can save time by purchasing two and three year old trees at once for the orchard.

There are many varieties of the pecan, and some are much hardier than others; but the few choice thin-shelled varieties have been greatly improved through systematic cultivation, and they are always found to be the most profitable for planting. Horticulturists say that the trees will grow wherever the hickories and oaks flourish, and that they will last from sixty to one hundred years, always improving in productiveness. In Texas growers frequently average $10 to $15 a tree fifteen years from seed planting. So popular has the industry become that a few years ago the owners of orchards on the gulf coast dug up orange trees to make room for pecan trees. The trees attained immense size and they have to be planted as far apart in the orchard as the apple, the average distance being from 34 to 42 feet. This is the regulation distance apart for the walnut, hickory, and chestnut trees. The almonds and filberts need to be planted closer together—from 12 to 15 feet. When grown for the timber as well as the nuts they are planted in rows 8 to 12 feet apart one way and 5 to 8 feet the other way.

The shellbark hickory is far more profitable to grow in many regions of the country than the peach. It comes into bearing in about ten years from the seed. The timber of an orchard of hickory trees is of itself a valuable investment in time. Timber men also figure out that it is a profitable investment to plant walnut trees on any land that can be purchased for $25 or less per acre. This is for the timber alone, and the owner has all the additional profit that comes from selling the nuts. Good walnuts sell readily in our markets, and they are easier to dispose of, as a rule, than apples. Trees planted for timber, however, will never produce as large a crop of nuts as an orchard planted in regulation style for the fruit. The trees must be planted close together for timber, and the crowding injures the nuts.

The white walnuts, or butternuts, are fairly profitable, but not so much so as the black walnuts. The English filbert is also being raised in this country with considerable success. It produces a fine crop in almost any region where peaches thrive, and, as everyone knows, the peach region in this country is wide and extended. The hazelnuts are found growing wild over millions of acres of land in the West and East; but the nuts have always been rather small and inferior. A large and important species has been found growing wild in the far Northwest, and the new trees are being used as stock for the general improvement of the nuts. By careful selection and cultivation the size of the nuts has been increased from one-third to one-half, and there is every reason to suppose that in the course of a few more years our common wild hazelnuts will be important commercial products. The improved English hazelnut is cultivated here successfully, and a considerable crop harvested annually.

Of almonds little need be said. California has entered so extensively into the work of raising them that the crop is valued at hundreds of thousands of dollars. This nut is a native of a warm climate, and its culture will never extend beyond the Pacific coast and the strip of land bordering the Gulf of Mexico.—New York Sun.

AUTOMATIC ENLARGING APPARATUS.

The automatic apparatus for enlarging photographic negatives was devised in response to the demand of those who found the images given by hand cameras too small. With the apparatus that we have hitherto described we are limited to one or two scales of amplitude of the negative in its entirety, while it would often be preferable to select some size that harmonized with the subject, and, indeed, even to take only a part of the negative and enlarge it further.

In this case, it is necessary to have recourse to the ordinary apparatus, in which one of the difficulties of the operation is the exact focusing. The grain of the ground glass, in fact, always leaves an indistinctness that is renewed at every change in the scale of the enlargement. M. Carpentier has devised an arrangement that does away with this delicate operation. The objective is always in focus, whatever be the respective positions of the negative and the sensitized surface. With lenses, as well known, the dimensions of the image of an object, and the respective distances of the image from the lens and of the latter from the screen, are connected by the law of conjugate foci, which is expressed by quite a simple formula.

The new automatic enlarging apparatus gives, in every position, a mechanical resolution of this formula. This result is obtained by means of a rigid square, which is movable around its angle, O (Fig. 1, No. 2), and which controls the motion of two slides, B and A, one of which carries the negative to be enlarged and the other the sensitized surface. The motion of these slides is produced by means of two metallic travelers that move in slots formed in the branches of the square. This device is placed in a platform that supports a triple bodied camera with bellows (Fig. 1, No. 1) analogous to the ordinary enlarging apparatus. One of the slides is connected with the front, B, of the camera, in which are placed the frames of different sizes designed for the negatives, and the other with the rear, A, at the location of the frame designed to contain the sensitized surface, glass or paper. A special arrangement of the negative carrier permits of placing at will the glass or the gelatine on the objective side, so that it may be possible, according to circumstances, to have reversed or non-reversed prints.

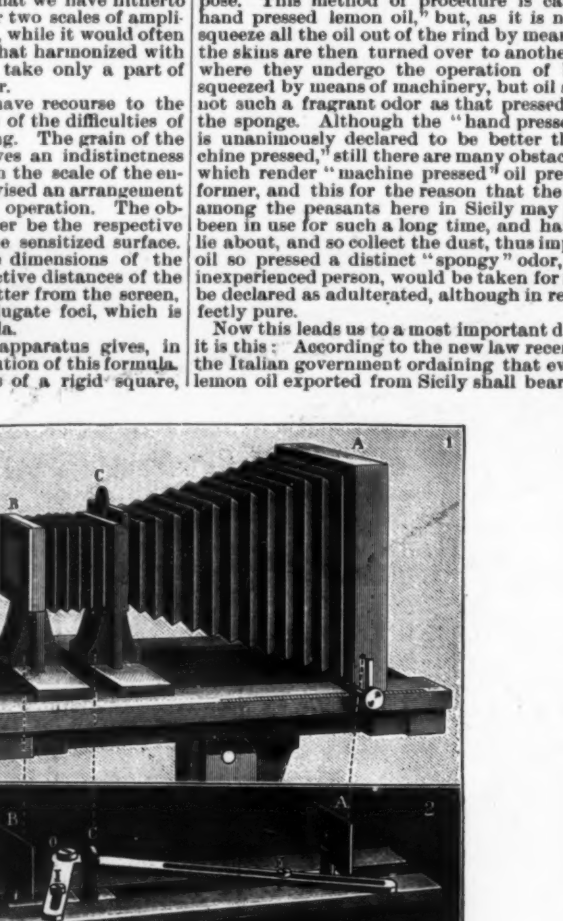
A reversed print is very advantageous in case it is desired, starting from a small positive, to obtain a large negative designed to be printed in carbon, because it is then possible to avoid the operation of a double transfer that this process necessitates when an ordinary negative is operated with. For photocollography the reversed negative is indispensable. By means of special frames, it is possible likewise to perform an operation inverse that of enlargement, and, from a large negative, to obtain a view designed for projection.

The body, C, of the middle of the camera (the one that carries the objective) is so placed that the optical center shall be in the transverse plane of the apparatus that contains the joint of the square. The two constants of the objective (the absolute focal distance and spacing of the nodal points) are directly determined by the precise processes of optics, and all the regulating consists in placing the joint of the square, as well as the frame and negative carrier, in the exact position that they are to occupy.

The motion of the square is controlled by the displacing of the back of the camera, which is done, as usual, by means of a milled button acting upon a rack.

The use of this apparatus will therefore prove a very great convenience, since one has to occupy himself only with the artistic side of the question, in observing upon the ground glass how the image presents itself in its different dimensions, without ever having to verify the focusing, which, by the mode of construction, is always perfect.

For the above particulars and the engravings we are indebted to La Nature.



AUTOMATIC ENLARGING APPARATUS.

OIL OF LEMON.*

By Franc. Ant. Corio.

Oil of lemon plays such an important part in the commercial world, especially among the wholesale drug trade, not mentioning wholesale confectioners, perfumers, soap makers, and soda water manufacturers, that I deem it opportune to enumerate here some facts regarding its production, exportation, and the many, many schemes that have been put in force for the prevention of its being adulterated with extraneous substances.

The true Sicilian oil of lemon is obtained by pressing the rind of the lemon by means of a sponge, which, when thoroughly saturated with the oil, is afterward squeezed into a receptacle made especially for the purpose. This method of procedure is called "making hand pressed lemon oil," but, as it is not possible to squeeze all the oil out of the rind by means of a sponge, the skins are then turned over to another department where they undergo the operation of being further squeezed by means of machinery, but oil so pressed has not such a fragrant odor as that pressed by means of the sponge. Although the "hand pressed" lemon oil is unanimously declared to be better than the "machine pressed," still there are many obstacles in the way which render "machine pressed" oil preferable to the former, and this for the reason that the sponges used among the peasants here in Sicily may perhaps have been in use for such a long time, and have been let to lie about, and so collect the dust, thus imparting to the oil so pressed a distinct "spongy" odor, which, by an inexperienced person, would be taken for rankness, and be declared as adulterated, although in reality it is perfectly pure.

Now this leads us to a most important discussion, and it is this: According to the new law recently issued by the Italian government ordaining that every copper of lemon oil exported from Sicily shall bear a label certifying as to whether it is pure or adulterated, any person or persons failing to comply with these regulations or falsely declaring the goods will be subjected to a heavy penalty and imprisonment, strikes me as rather inadequate, the more so that I ask anybody whether it is right and just that an oil of lemon pressed, say, from discarded fruit, of a dirty, mildewy appearance, and pressed by means of a dirty sponge, should be declared as pure. Yet, according to these regulations it will be declared as such, for the analysis will declare the oil to be free from any extraneous substances. Therefore, in a technical sense, the oil is pure! Again, what is there to prevent unscrupulous dealers down here in Sicily from pasting on the copper vessels labels certifying a certain oil to be adulterated (which in reality it is), so as to comply with the government regulations, but in the meantime instructing his agent on the other side to tear off those labels, once the goods have arrived at their destination, and paste on fresh labels boldly asserting the oil to be "absolutely pure"? When the oil is shipped direct to the consumer himself this system of fraud is somewhat obviated, of course, but as the majority of oil shipped is on consignment, one will readily understand how easy it is to perpetrate such fraud. In order to cope with this difficulty I would suggest that the Italian consuls resident in different parts abroad be authorized from time to time to visit the warehouses of the importers themselves and take samples to be sent to some head station for analysis to see if they comply with the declaration given at the port of exportation. Indeed, this important question of adulteration is one which requires a great deal of "thrashing out," but as no reliable and uniform method of analysis has yet been agreed upon, we are practically in the dark. One person bases his analysis according to citral percentage, another according to optical rotation, sp. gr., and so forth, but where do these tests lead one to in the end? Certainly, they are far from satisfactory, and instead of doing good, create confusion and mistakes. Take the citral test, for instance. As everyone knows, a lemon pressed in the month of March will give a higher percentage of citral than one pressed during the month of November, when the pressing of new crop oil commences, and the fruit

* Pharmaceutical Era.

is still green. Yet no one can dispute that for fineness and delicacy of flavor, combined with natural strength, "November pressed lemon oil" cannot be beaten. The majority of perfumers will have nothing but "November pressed" oil. If, however, they buy according to citral percentage, they certainly do not get "November pressed" oil; besides, fruit of later cuts costs the merchant less. Again, optical rotation and sp. gr. vary according to temperature, districts from where the fruit is obtained, and many other things which prevent the reliability of the results obtained. Oil of lemon and turpentine both belong to the family of terpenes, yet, by a little manipulation, it is practically an easy matter to arrange the lemon oil given for analysis so that the required optical rotation is given, even when adulterated with rectified oil of turpentine. Now, it may perhaps seem rather out of place here to uphold the much derided "nasal" test, but if all other methods have failed, why not give this test at least a trial? By this method I might say that one can detect turpentine in oil of lemon, by a peculiar, pungent odor which is seemingly apparent, such odor, however, in many cases, being mistaken for "strength." Not only can one by this method say whether oil is pure or not, but one can as well say from what district the oil comes, i. e., whether from the district of Palermo (this oil can be obtained at prices ranging from 15 to 20 per cent. lower than the genuine Messina oil, owing to the absence of true flavoring principle), Calabria or from mountainous or flat country. Can the chemist tell you these things? No. You might say, I do not care to know from what district my oil comes, as long as it is pure. Yes; your reasoning is feasible, but if you are a consumer you do not buy your oil for the sake of "purity" alone. You want your goods to be distinctly superior to those of your competitors, and if you can obtain an oil possessing a more delicate and fragrant aroma than that you have been already buying, you would certainly give that oil the preference.

It is not always the fault of the exporter here that an oil is declared as adulterated, when perhaps it may be pure, as a great deal depends on the containers of the oil, inasmuch as if a consumer of say 200 pounds of oil per annum buys his oil in one large copper, the number of times that he will have to open that vessel in the course of the year in order to obtain his supplies will let in the air and light, with the consequent result that perhaps before six months have elapsed that oil will be on the way toward deterioration, and the merchant over here will receive a letter to the effect that he cannot understand how it is that the oil shipped on such and such a date has such a "decidedly rank odor." If, however, an oil is put up in say a 10-pound copper, and kept intact until the actual time of consumption comes to hand, even if it be ten years hence, on opening the copper the oil contained therein will be found to be just as fresh and pure as if it was at that very moment pressed from a lemon just cut from the tree. It is exposure to light and air that causes the early deterioration of oil of lemon.

Limpidity of the oil is also another point greatly desired by the consumer, but how many are aware that rectified oil of turpentine is just the thing to give this limpidity? Of course, I don't mean to say that because an oil is thick and cloudy that is a guarantee of purity, but it certainly stands just as good a chance of being pure as the perfectly clear oil.

Returning again to adulteration with turpentine, I might say that oil of sweet orange is very often employed to cover up the rank odor of turpentine, but this only when orange oil can be obtained at a comparatively low figure. For instance, at the present moment it would not be used, owing to the high price.

In conclusion I would say one word to all lovers of pure goods, and it is this: Do not cut down your price to such a low figure as to render it impossible for your supplier to furnish you with the genuine article, thus enticing him to furnish you with a dose or two of turpentine. Again, as lemon oil is obtained, in the first place, through the medium of the peasant, it is therefore very important that the merchant right here in Sicily should be a thorough "connoisseur" of the article and know what he is buying, as this latter is a point which very often causes friction among customers owing to the inability of the exporter to detect even himself an impure parcel.

Messina, May 14, 1898.

TEMPERATURE OF EBULLITION OF LIQUID OZONE.

MESSRS. HAUTEFEUILLE AND CHAPPUIS were the first to obtain ozone in the state of a dark indigo blue liquid. This was in 1882. The experiments relative to the determination of the temperature of ebullition of this liquid were made in 1887 by M. Olszewski. This skillful experimenter, after liquefying ozone in a tube cooled to —184·4° through liquid oxygen in ebullition at the pressure of the atmosphere, ascertained that ozone vaporized only very slowly when the tube was placed in liquid ethylene cooled to —140°, but that it vaporized very rapidly when the temperature of the ethylene closely approached its boiling point. From this he concluded that the temperature of ebullition of liquid ozone ought to be close upon —106°. I resolved to fix such temperature with greater precision. For this determination I employed as a thermometric apparatus a Constantan iron couple that furnished a curve given by the temperature of melting ice, by the points of ebullition of the chloride of methyl (alone or traversed by a rapid current of air), by the temperature of a mixture of solid carbonic acid and chloride of methyl,* by the boiling point of protoxide of nitrogen

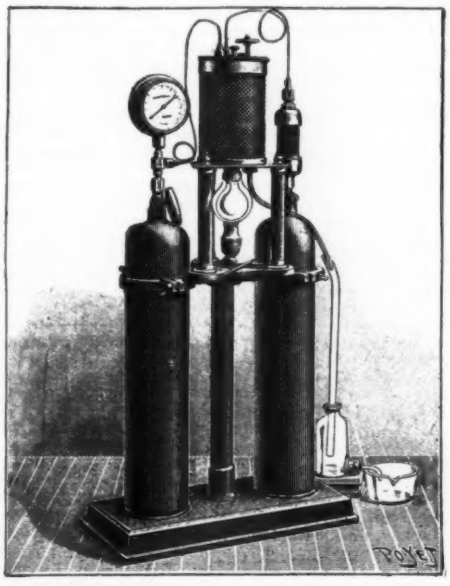


FIG. 2.—APPARATUS FOR MANUFACTURING LIQUID OXYGEN.

and that of liquid ethylene, by the temperature of fusion of solid ethylene, and by the boiling point of liquid oxygen at the pressure of the atmosphere. By means of this apparatus, it was possible to ascertain the temperatures to within less than about half a degree.

The ozone was obtained by means of the Berthelot ozonizer, *E* (Fig. 1), kept at about —79° by means of a mixture of solid carbonic acid and chloride of methyl. The liquefaction of the ozone was effected in a vertical tube, *F*, the lower part of which was immersed in a bath of liquid oxygen contained in a cylindrical glass vessel with double walls, and an intermediate space in which a Crookes vacuum had been made as recommended by Prof. Dewar. The ozone liquefied before entering the part of the tube immersed in the bath of liquid oxygen, and at a point situated at about two centimeters above the level thereof, thanks to the low temperature maintained therein by the gaseous oxygen.

The liquid ozone collected in small drops of oily aspect, not adhering to the glass, and descended to the base of the tube, at the bottom of which had previously been placed one of the weldings of the iron couple,† the other welding, *G*, being kept in melting ice. Afterward, in order to determine the temperature of ebullition of the liquefied ozone, the bath of liquid oxygen was so lowered that its free surface should be more than three centimeters beneath the lower extremity of the tube in which the ozone was collected, and the successive deviations indicated by a Deprez-d'Arsonval galvanometer were noted. The deviation, after diminishing slowly, remained constant during the period of boiling of the liquid ozone, and then diminished anew and very rapidly until the welding of the couple had reached the temperature of the gaseous oxygen at this point.

The stationary deviation given on the curve corresponds to a temperature of —119°. I repeated this experiment several times with different quantities of liquid and always obtained the same result. It may be concluded from this that the temperature of ebullition of liquid ozone at the pressure of the atmosphere is —119°.

The liquid oxygen employed in these experiments was obtained by means of an apparatus (Fig. 2) constructed by Messrs. Lennox, Reynolds & Fyfe, according to instructions given by Prof. Dewar. This

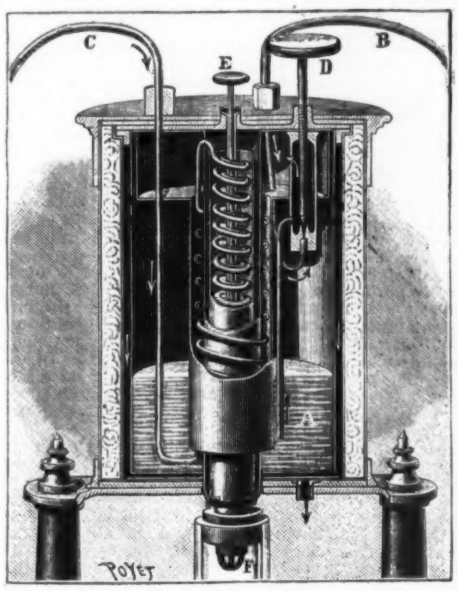


FIG. 3.—SECTION OF THE OXYGEN AND LIQUID AIR REFRIGERATORY.

A, alcohol in a receptacle isolated with cork; *B*, tube through which the liquefied carbonic acid enters; *D*, expansion cock of the liquefied carbonic acid; *C*, tube through which the compressed oxygen enters the spirals cooled to —79°; *E F*, expansion cock of the compressed oxygen.

apparatus, which utilizes compressed oxygen such as is found in the Paris market, causes the expansion of it at *F* (Fig. 3) after cooling it in its passage through a very long tube, *C* (Fig. 3), which is wound in three parallel spirals and terminates at the orifice, *F*. This tube is kept at —79° through a mixture of solid carbonic acid and alcohol. It is possible in this manner to obtain in a laboratory or an amphitheater, without a compression pump and without any motive power, about 15 cubic inches of liquid oxygen in less than half an hour.—L. Troost, in La Nature.

* The temperatures were given in this case by means of a thermometer graduated according to the indications of the hydrogen thermometer.

† An experiment in which one of the weldings of the couple (already cooled with gaseous oxygen) was placed in ozone previously liquefied and kept at —184·4° was interrupted by a violent explosion.

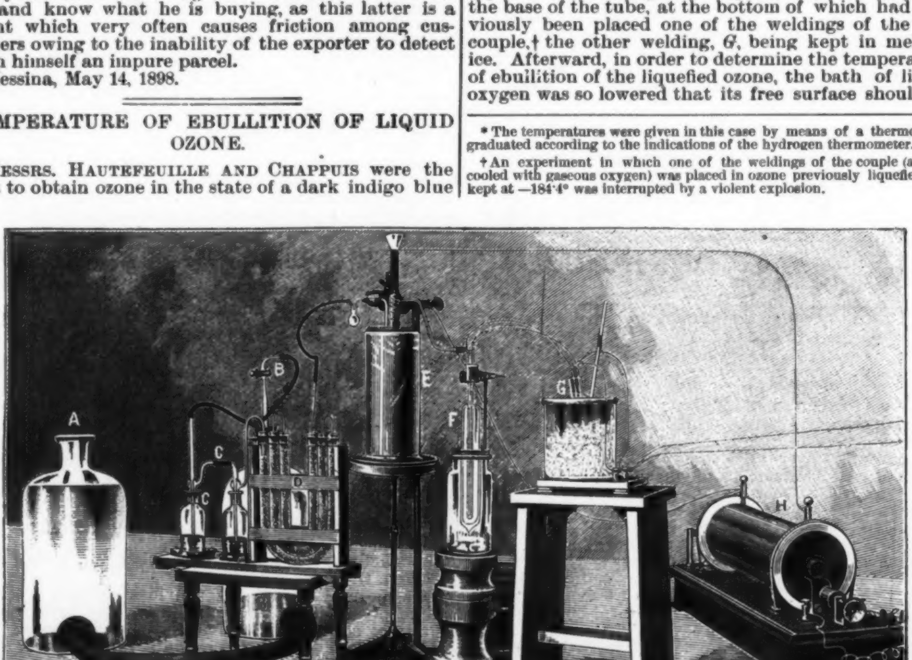


FIG. 1.—PREPARATION OF LIQUID OXYGEN.

A B, oxygen gasometer; *C C*, purifiers; *D*, desiccators; *E*, Berthelot ozonizer; *F*, ozone condenser; *G*, one of the weldings of the thermo-electric couple; *H*, induction coil.

Now that the United States navy will probably be obliged to rely upon far Eastern dockyards for many repairs to its ships on the Asiatic station, it becomes of interest to note the great improvements in progress at Nagasaki, Japan, says The Army and Navy Journal. By recent official information received at the Navy Department it appears that the Mitsu Bishi Company, of Nagasaki, has completed the changes to its former drydock system and now possesses one of the best plants for docking large ships in the East. Dock No. 1 has been lengthened so as to take ships up to 500 feet in length of the heaviest draught. This company has the contract to do the building and repairing for the big Japanese navigation company, the Nippon Yusen Kaisha (formerly known as the Mitsu Bishi). As is well known by our naval officers, the harbor of Nagasaki possesses the best facilities for repairs and coaling in the world. The winds are seldom violent, the tides comparatively small, there are no currents in the harbor and the holding ground is of the first order. It is also one of the healthiest ports in the East. Labor, shops, coal, and pure water are abundant. The docking capacity is now equal to five ships at one time. According to the reports made to the Board of Directors for 1897, not less than eighty-nine vessels were docked, aggregating a tonnage of 217,037. The number of workmen employed is about 2,500.

"**In 1896** there were 483 strikes in this empire, with 128,808 persons actively participating," according to Consul Monaghan, of Chemnitz. "They lasted altogether 1,923 weeks and cost in actual expenditures out of labor organization funds, to say nothing of the losses in wages, 3,042,950 marks (about $714,000). In 1897 there were 578 strikes actively participated in by 63,119 persons. They lasted 1,921 weeks and consumed, exclusive of wages, etc., about $362,000. Thus the number of strikes was 95 less, the number of persons participating less by 65,789; the duration was about the same, and the expenditures smaller by about $361,000. This difference is due to the strikes by the dock laborers and textile workers in 1896, in which 55,510 persons took part. Among the trades, workers in wood led with 64 strikes, 12,036 persons participating, and the expenses being about $42,364. Shoemakers follow with 52 strikes, 6,193 participants; formers with 50 strikes and 2,132 persons; metal workers, 29 strikes and 2,023 persons; workers in tobacco, 24 strikes and 625 persons. Participants, as a rule, seek employment in other places and are supported out of the funds till work is found. Workers in the same branch, if enrolled in a labor organization, are not allowed to go into a boycotted shop."

TORPEDO BOAT DESTROYERS.*

FOR SEA SERVICE, WITH SPECIAL REFERENCE TO THE CONDITIONS THAT PREVAIL ON THE PACIFIC COAST.

By G. W. Dickie, Esq.

Important naval events are occurring in such rapid succession, modifying opinions that we have maintained as perfectly sound, and forcing others to be abandoned that we had considered as firmly established, that any attempt to produce a paper on the subject I have been requested to write upon may fail to express the opinions of the author when it comes to be presented before the society. In fact, this is the third attempt (begun on the first of August) to put in presentable shape the conclusions arrived at in regard to the chief characteristics required in a design of a torpedo boat destroyer that would meet all the conditions of service on the Pacific coast.

On the first page of a paper that I have just laid aside as not expressing the opinions I now hold, I find the following, that expresses the difficulty of presenting this subject:

"I feel at the present date (April 25, 1898) that I am running some risk of losing any little reputation that I may now possess by the expression of opinions that the stern facts of actual service in any war may prove to be entirely wrong. Still, I desire, if possible, to complete this paper before anything happens that would in any way modify the opinions I now hold in regard to the utility of the latest developments in the construction of the type of vessel known as the torpedo boat destroyer."

More events have taken place since the above was written than usually occur in three months of naval history. In fact, these three months have provided material enough for naval architects, marine engineers, and ordnance experts to form opinions from for years to come. It takes time, however, to form opinions, and more time to give them anything like practical form, and still more time to test the material forms into which these opinions finally shape themselves. The opinions expressed in this paper have not been entirely formed from the naval events of the past three months, although some of them have been modified by these events.

The conditions of service are not altogether those that war produce. A seaworthy vessel must possess many and varied qualities apart from those belonging to the special service in which the vessel is engaged. A vessel built with the special object in view of carrying large cargoes at a low rate of speed and a low rate of freight must have, besides the capacity to carry, the ability to safely meet the storm conditions of the ocean on which she and her cargo are borne. A fast passenger steamship, built with the special object in view of obtaining the greatest possible speed within the paying limits of the service, must still conform to the stern requirements that the ocean imposes on all those who "go down to the sea in ships and do business in the great waters."

A torpedo boat destroyer must possess other qualities than those necessary for the destruction of torpedo boats. In fact, the destroyer must be a seagoing vessel, able to remain at sea with the fleet to which she is attached or to make independent voyages.

The torpedo boat is intended, if the writer understands the purpose for which such craft are designed, as a part of harbor or coast defense, to be kept under shelter until a chance occurs for her to dart out, under cover of night or fog, and attempt to sink a hostile vessel or vessels. Her work is, therefore, short and sharp, requiring a supreme effort, well directed, and of short duration.

The work of the torpedo boat destroyer is to prevent the torpedo boat attack, and is, therefore, performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo boat. She must, therefore, possess speed equal to that of the torpedo boat; a battery powerful enough to destroy her; seagoing qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be an ideal torpedo boat destroyer.

It cannot be said that the present type of torpedo boat destroyer comes near meeting these requirements. Quite a large number of destroyers now meet the requirements, in the matter of speed, if required for a short time only, in smooth water, and if she is in good order; but the one quality of speed has been made paramount to all other qualities to such an extent that full speed can only be reached when the conditions are such that the seagoing qualities can be neglected.

It is because we think that the most important qualities required in a sea-going vessel are deliberately neglected in the fastest torpedo boat destroyers, and which we feel renders such vessels entirely unfitted for service on the Pacific coast, that we have mustered courage enough to state, as plainly as we can in words, the deliberate opinions we have formed on this subject.

While the conditions of service for such a vessel on the Pacific coast are not different in kind from those that prevail on the Atlantic seaboard of this country, the adverse conditions are far greater on the Pacific.

The great distance between harbors on the Pacific coast and the almost universal condition of rough water along the coast from Point Conception in the south to Cape Flattery on the north, with only one place of refuge, renders it necessary that any vessel for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound must have good sea-going qualities and be able to remain outside in all conditions of weather.

The qualities necessary for this service are not possessed in any degree by the present type of torpedo boat destroyer. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel. They have needed extra care, both in watching the weather, taking advantage of every shelter that lies in the way, and if the destination is reached without mishap, it is something to be proud of, as being entirely outside of the service for which the vessel is fitted.

Now, such a vessel in commission on the Pacific coast cannot go from San Francisco Harbor to any other harbor without making an ocean voyage of several hundred miles, with a probability of encountering rough weather.

The disastrous results of many late attempts to steam or tow light craft to Alaskan waters, most of them better able to stand rough water than the fastest type of torpedo boat destroyers, show the necessity of substantial sea-going vessels for service on this coast.

The 420-ton destroyers lately ordered by our government are a decided improvement in this class of vessel, but we do not think they are fitted even yet to meet the special conditions of service on the Pacific.

The annexation of the Hawaiian Islands requires a much greater radius of action for such a vessel, and, we think, a different treatment. In fact, we maintain that if 30 knots or over is aimed at as the supreme speed, a sufficiently stanch sea-going vessel cannot be produced in the present state of the art, and that the present so-called 30-knot torpedo boat destroyers have not, in fact, the speed with which they are credited as being available when required.

The supreme efforts required, under expert management and with special trial trip crews, to reach the contract requirements are seldom or never repeated in the life of the boats.

If these boats and their machinery were made more substantial, so that their full power could be exerted at any time and without risk, and the hull stand a moderate sea without danger, the 30-knot boat, by reason of the extra displacement, would drop to about 27 knots; yet we venture to assert that such a boat, ordered to reach a point at sea, say one hundred miles distant, in the shortest possible time, would reach the objective point in less time than the regulation 30-knot boat that is said to get a horse power in 50 pounds weight of machinery. A large proportion of naval vessels rated at high speeds, especially those over 20 knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy engined, 16 or 17-knot boat may outstrip them in a fight.

Whatever speed a fighting ship has ought to be produced when ordered from the bridge. An Atlantic liner would not be considered a success if in ordinary weather she could not cross the ocean at very near her trial speed, and if the machinery of a naval ship were as substantially built, she could do the same, if necessary, as long as her coal held out. Merchant ships are now making the longest possible sea voyages with a steady and continuous production of steam greater than that produced per foot of grate in naval vessels in three, four, or six hours forced draught trials that are said to be so destructive to boilers.

In the merchant service machinery is built for full power as a normal condition. In the navy full power is only to be resorted to under great necessity, and maintained at a terrible risk; hence the difference.

Returning to the subject proper of this paper, we would propose for a torpedo boat destroyer adapted for service on the Pacific coast the following general characteristics as necessary to meet the conditions of the varied service required, the outline drawings accompanying this paper being illustrations of how we would embody these qualities in a sea-going vessel:

Length on normal water line	250 ft.
Extreme width	25 "
Depth moulded	15 "
Draught of water on trial	8 "
Draught of water loaded	9 " 5 in.
Displacement on trial	640 tons.
Total load displacement	800 "
Indicated horse power on trial	7,000 "
Speed on trial	25 knots.
Radius of action, 12 knots	3,200 "
Best speed from San Francisco to Honolulu	15 "
Best speed from San Francisco, to Puget Sound Naval Station, or San Diego, good weather	20 "

The weights provided for are as follows:

Ordnance	36 tons.
Machinery, including water in pipes and boilers, evaporating plant, tools, spare parts, water in water tanks, etc.	230 "
Hull, complete, and fittings	300 "
Crew and effects, including portable furniture	14 "
Coal at normal trim	60 "
Making the normal displacement	640 "
Coefficient at 8 feet draught	0·448

With bunkers full of coal there would be 160 tons added, the full coal capacity being 200 tons.

As will be observed by the outboard profile, we have designed this vessel to have a full forecastle, extending to the foreward fireroom, and a half poop extending to the engine room. Between the poop and forecastle a hammock berthing extends the full length.

The 6-pounder guns, of which there are six, would be carried on rail mounts above the hammock berthing. This arrangement would give very good quarters, both for officers and crew.

Casings around the two smokepipes are carried up high enough to carry the inner ends of the boat skid beams. This enables four boats to be carried, while the casings furnish room for the galleys on deck.

We propose to carry two 4-inch rapid-fire guns, one on the forecastle deck and one on the poop.

The conning tower is of 1-inch nickel steel.

There is a chart house aft of the conning tower and a bridge above. There is also an after steering house on the poop. This covers the stairs to the officers' quarters and carries the searchlight above. This light would be controlled from the forward bridge.

The machinists would occupy a space at the forward end of the poop, entering from the landing leading to the engine room, aft of which would be the ward room and officers' state rooms. The total complement of officers and crew would be seventy-five.

We have, in this vessel, purposely omitted all deck torpedo launching tubes, believing that they should form no part of the armament of a sea-going torpedo boat destroyer, as such a vessel must be prepared to go into action along with the fleet of which it forms a part. Superior speed would enable her to choose the kind of vessel with which she would engage. The deck tubes would, in such a case, if there was any intention to use it, contain a charged torpedo that would, in such an exposed position, be a constant source of dread to those on board. We have, therefore, arranged for two special submerged torpedo tubes in a protected compartment aft of the engine room. Owing to the limited width of the vessel, these tubes would be designed to open on top instead of at the inner end. We believe that there is no mechanical difficulty in designing the discharging tube and the impeller that carries the torpedo clear of the skin of the vessel before release, so as to admit of the torpedo being placed in the tube from the top side.

The sloping sides of the torpedo room would be of 1-inch nickel steel. We have also provided 1-inch nickel steel protection extending the whole length of the engine and boiler compartments, so as to give a moderate amount of protection when the coal bunkers are empty.

We have shown four Thornycroft boilers in our design and four cylinder, triple expansion engines of 7,000 horse power. We have allowed thirty tons extra weight for the machinery above that allowed for the same horse power in the usual types of torpedo boat destroyer, so as to have a fair margin of safety in all main parts of the engines and boilers.

In this design our aim has been to produce a sea-going torpedo boat destroyer that can go to sea and remain at sea without any special risk, and at sea can maintain a speed of 25 knots for a few hours when such a speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch boat, whenever or wherever such service is required; that carries a battery that makes her a torpedo boat destroyer in fact.

This boat would show better speed under regular service conditions than any of the so-called 30-knot torpedo boat destroyers, and for seaworthiness, habitability, or fighting capacity far outranks them.

* Read at the sixth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 10 and 11, 1898.

DESIGNS OF THE NEW VESSELS FOR THE UNITED STATES NAVY.*†

By Chief Constructor Philip Hichborn, United States Navy.

The proceedings of this society form so convenient and—if I may be allowed to say it—so valuable a reference in regard to the general design of the various types of vessels comprising our naval force, that I felt I could not consistently refuse to contribute a paper at the present meeting, notwithstanding the fact that I had hardly time to do proper justice to the subject.

Since our last meeting, practically every type of vessel the government possesses has been put to the test in engagements with the enemy. There is no record, so far as I know, of the failure of any vessel to fulfill all expectations. The wonderful success attending these naval engagements has impressed the country at large with the value of, and the necessity for, an efficient navy. Congress responded to this sentiment promptly and liberally, and within the past six weeks contracts have been made for three additional battleships, four coast defense monitors, sixteen torpedo boat destroyers and twelve torpedo boats. A full ship-rigged sailing vessel was also authorized as a practice ship for the Naval Academy, and is already under way. There are a few features connected with each to which I wish to invite your attention. At the present stage I am able to give only approximate data regarding the battleships, being the result of preliminary calculations in connection with one design.

Particulars regarding each design are arranged as conveniently as possible in the form of an appendix, and fairly complete plans—upon which the paper depends principally for its value—are attached.

BATTLESHIPS.

Believing that the "Alabama" class represented an efficient type, the Department in issuing circulars and plans for the three vessels appropriated for concluded practically to duplicate that class as regards size, speed, armament, etc. It was decided, however, to invite bidders to submit their own designs, offering preference—other things being equal—to bids guaranteeing the highest rate of speed and greatest coal endurance, without exceeding the total weight of engines, boilers, and coal, or the space allowed therefor, as provided in the Department's plans and specifications.

The result was highly satisfactory. The designs submitted, after some revision, provided in effect an 18-knot vessel 20 feet longer and of 1,000 tons greater displacement, but in other respects conforming to the original plans and specifications, excepting, of course, the changes in design of boilers and engines to meet the additional requirements of power on the weight allowed.

The preliminary acceptance of these propositions had to be followed by a revision of plans and specifications before any contract could be drawn. At the time of preparing my paper, this work was still in hands of the builders, and I regret having been therefore unable to obtain plans and particulars as complete as I should have liked. General plans of the "Maine," intended to accompany the contract, were received in time to allow their utilization in illustrating the paper, and will be found appended. While there will probably be some variation from these plans in the other vessels, as regards the type of boilers and engines, they may be considered as fairly representing the class, and an examination will show that, in general, the vessels will be enlarged and speedier types of the "Alabama."

General dimensions and particulars of this design are tabulated in Appendix I. As remarked in the introduction, however, very little of this information can be considered as absolutely accurate or fixed, as a great deal of it is the result of only the preliminary design and calculations.

The machinery details, it must be remembered, are for one of the three designs only.

A clause in the contracts provides suitably for the making of certain changes in armor and armament, within six months, such changes being suggested by recent developments in the manufacture of armor and guns. It is believed, for instance, that a reduction of at least 25 per cent. in the thickness of heavy armor can be made when treated by the Krupp process without lowering its efficiency in resisting penetration.

* Read at the sixth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, Noven r 10 and 11, 1898.

† In the current issue of the Scientific American will be found illustrations and diagrams, with a detailed description, of the amended designs for the ships of the "Maine" class.

This will be found suggested in the design here presented, although the matter is not definitely settled at this time. The latest type of 12-inch gun, with smokeless powder giving a muzzle velocity of 3,000 feet per second, is believed equal if not superior to the 13-inch guns of our present battleships. England is limiting the size of her heaviest guns to 12-inch, and other European navies are installing nothing larger. This change to 12-inch guns is therefore to be expected in the designs in question, and the number of 6-inch guns will, of course, be increased as a consequence—probably to sixteen. The secondary battery provided in the "Maine" design has been increased over that of the "Alabama" class, on account of increase in the length of the vessel. The number of 6-pounder guns stated may also be changed somewhat.

One very important improvement in the new battleships will be the installation of under-water torpedo tubes. There will be two of these submerged tubes in a single compartment fitted up for the storage of eight 17-foot torpedoes and appliances for handling and operating the same. The war heads will be conveniently stowed in a separate compartment.

We have been rather tardy in adopting the submerged discharge for torpedoes, but the matter has been made the subject of considerable study and some experiment, so that it is to be hoped that our first attempt at this difficult installation will be more successful than some of the early efforts of European designers in this connection.

It is interesting to note, under the schedule of weights given in the appendix, which represents the vessel in trial condition, in which she is to attain a speed of 18 knots, the relatively large amount of coal, ammunition, and stores to be carried on trial.

The total coal bunker capacity is also very large, it being fixed at 2,000 tons. This, of course, involves the closest possible stowage, and the figures cannot therefore be compared with those based on loose stowage, as given out for our previous battleships.

It will also be seen by comparison between the estimated collective I. H. P. and the total heating surface of the boilers, that the number of square feet of heating surface per horse power is over 3·6. These figures, of course, are only estimates as yet.

Considered as a whole, however, the new designs for battleships—with the slightly lengthened hull and general arrangement of the "Alabama" class, with the immense addition in engine power, and with the improved armor and armament likely to be fitted—certainly embody the very best features known to naval science.

It is of special importance that the improvements in design have been accomplished with practically no sacrifice in draught, in which respect these ships will have an advantage of from 18 inches to 2 feet over vessels of their same class and size in Europe.

The fact that the contract price for hull and machinery for the "Maine" class will exceed by less than 10 per cent. that of the "Alabama" class speaks well indeed for the progress of the shipbuilding art in this country. The contract time, furthermore, has been reduced.

TORPEDO BOATS AND DESTROYERS.

The portion of the appropriation bill providing for these vessels authorized the construction of "sixteen torpedo-boat destroyers of about four hundred tons displacement" and of "twelve torpedo boats of about one hundred and fifty tons displacement," all to have "the highest practicable speed."

In fixing, approximately, the sizes of these vessels, Congress was guided by the consensus of opinion of naval experts, as determined by the experience of the past few years with sea-going boats.

Unfortunately, the half dozen 30-knot boats being constructed for the government by different firms had not been completed. These boats are all being built on contractors' design, it having been deemed advisable heretofore to allow bidders every possible latitude in meeting the unusual speed requirements.

This year, however, plans of both classes were prepared, and bids invited for their construction on these designs or on designs to be submitted. In the case of bidders' plans, however, the displacement for trial was fixed within close limits, so that the designs submitted were such as to be readily compared with each other and with the Department designs. Special consideration was offered to guarantees of completion in a time below the limit fixed—one year for torpedo boats and 18 months for destroyers—and to guarantees of speed above 26 knots in the case of the smaller boats and above 28 knots in the case of the larger.

TORPEDO BOATS.

As to the designs of these boats, the Department's plans were similar, in many respects, to those of the "Winslow" class, which were prepared in the Bureau of Construction and Repair a few years ago when the "Cushing" represented the full strength of our torpedo boat fleet. The new boats are 15 feet longer and of from 20 to 25 tons greater displacement. The speed is of course greatly increased over the 24½ knots which was considered about the highest practicable speed for small boats—in this country, at least—at the time the "Winslow" was designed.

The form of stern differs considerably from that of the "Winslow" class; otherwise the two models are rather similar.

The assignment of quarters for officers forward and for the crew aft, and the relative arrangement of boilers and engines in separate compartments, is entirely similar to that of the "Winslow." The officers' quarters are a trifle less roomy, but those for the crew more so. More deck room has been provided by doing away with the round at side which experience has shown to present more drawbacks than advantages. The position of the forward torpedo tube has been changed, bringing it considerably farther aft. This is also the result of experience, following the abandoning of the fixed tube in the bow.

Such of the bidders as presented their own designs did not vary greatly from the Department design, in so far as the hull and general arrangement were concerned, except in the case of the Bath Iron Works, which submitted plans similar to those of the 30-knot boats of the "Normand" type, which they are now completing under a former contract. This firm was awarded a contract for three boats, which are to make a speed of 28 knots on trial. The remaining nine boats, to be built on the Department plans, designed for a speed of 26 knots, were distributed among various firms.

TORPEDO BOAT DESTROYERS.

The designs prepared in the Department for these vessels cannot be referred to any particular type. The midship section approximates to the oval form largely adopted by the French. The sections toward the stern are original, though resembling somewhat the form given by Thornycroft to his twin rudder boats of some years ago. The relative arrangement of engines in separate compartments, between boilers, is similar to that on the torpedo boats. The officers and petty officers are quartered aft and the crew forward, under a raised forecastle. Four officers and a crew of 60 are provided for, with stowage for 20 days' provisions.

In addition to coal abreast the machinery, there will be the protection of 12½ pound nickel steel plates over a portion of the deck and on the sheer strake. The forward conning tower is of ½-inch nickel steel plates.

The vessels carry a battery of two 12-pounder and five 6-pounder guns, with two long torpedo tubes mounted on the midship line. Two cutters, one whaleboat, and two folding boats are to be carried.

Certain builders presented their own plans, differing in various respects from the Department's designs. In practically all cases the forecastle deck was left off and the turtle back construction substituted. In several instances the arrangements of officers' quarters and crew space were entirely altered. The form of the entrance and run was also altered in most cases to accord with the tastes of the designers. Speeds as high as 30 knots were guaranteed. Specifications were altered to meet the different designs, but on the whole—the vessels being limited between 400 and 435 tons—the variations in designs were not material and the bids accompanying them received due consideration. Seven vessels were awarded on bidders' plans, being on three different designs which are illustrated by accompanying plans. The remaining nine vessels were divided among four firms. Slight modifications were made in the contracts for these, in several cases involving an increase of speed to 29 knots on slightly decreased weight. The seven boats to be built on bidders' plans are to make speeds of 29 and 30 knots.

An important and somewhat novel feature of all the destroyers is the introduction of bilge keels, decided upon as the result of experience at sea with even the largest of our torpedo boats, which have been found to wear out the crews in a very few days, principally by excessive and lively rolling. These are the boats that will be expected to keep the seas in the future, and the fitting of bilge keels was thought to be important. Bidders were inclined to shirk them, because they were considered an uncertain factor in the high speed required. They were retained in all contract specifications, however.

In both the torpedo boats and destroyers, the wood has been required to be fire-proofed and its use reduced to a minimum. The vessels will be lighted throughout by electricity and fitted with search lights. Special attention will be paid to adequate ventilation, and every comfort and convenience consistent with the type will be supplied.

No firm attempted to contract for completion in a less period than the 12 and 18 months maximum allowed. This was to be expected after the experience of builders with this class of vessels so far. It is to be hoped, however, that future results will be more satisfactory.

The requirements of the contract provide in each case for the maximum speed guaranteed to be maintained during a run of two hours.

PRACTICE VESSEL FOR THE NAVAL ACADEMY.

My object in adding the plans and a brief description of the "Chesapeake" to my paper is to supply a type which I think has not yet appeared in any of the society's transactions, believing that the same will prove of some interest and value to members and subscribers.

This vessel now under construction at the Bath Iron Works will, when completed, fill a long-felt want at the Naval Academy, where for years past the cadets have had to make their practice cruises on obsolete types of vessels, fitted temporarily for the service, missing the important advantages of modern ship construction, modern battery, and the comforts naturally attached to modern design.

The appropriation for this much needed vessel last year was unfortunately confused. After deciding that a full rigged sailing ship was the proper type for the cadets, the wording of the bill was such as to include propulsion by sail and steam, although the estimates in the hands of the committees did not cover such a design. In amending the bill to exclude steam propulsion, however, the amount of the appropriation was reduced by half, so that the funds available were insufficient for a suitable practice vessel for the Naval Academy. The design was developed, however, as originally intended, and bids invited for the construction of the hull and so much of the fittings as the limited extent of the appropriation would permit. Further funds were made available in February last, increasing the available amount to $250,000. The contract was finally signed on March 16.

The keel of the "Chesapeake" was laid August 2 of this year. The spars, boats, and outfits, furniture, etc., are in course of construction at the Boston Navy Yard, and, after the completion of the hull and fittings of the vessel at Bath, she will be rigged and equipped at that yard.

The plans attached indicate very closely the general features of design and construction. The hull is to be of steel, but sheathed with 4 inches of yellow pine from the keel to about 2 feet above the water line and coppered. The lower masts will be of steel and the yards and other spars of yellow pine or spruce.

The details of design were prepared with the greatest care and met with the complete approval of the superintendent of the Naval Academy before being submitted to builders. There will be a modern battery and a complete installation of steam pumps, electric plant, distilling plant, refrigerating plant, steam heat, etc., with the boilers necessary for these auxiliary purposes.

The design of the vessel having been based, from the first, on the particular requirements of the service for which she was intended, it is safe to predict a decided improvement in the course of practical instruction at the Naval Academy.

NOTE.—In the current issue of the SCIENTIFIC AMERICAN will be found drawings and a description of the final, accepted designs of the "Maine" class.

APPENDIX I.

BATTLESHIP "MAINE."

DIMENSIONS AND PARTICULARS.

HULL.

Length on load water line	388 ft.
Length over all	393 ft. 9 in.
Breadth, extreme	72 " 2½ "
Freeboard, forward	20 "
Freeboard, aft	13 " 3 "
Freeboard, amidship	20 " 3½ "
Mean draught, with 1,000 tons coal and all stores and ammunition	23 " 10¼ "
Corresponding displacement (trial)	12,500 tons.
Speed per hour in knots	18
I. H. P., with assisted draught	16,000
Mean draught, with all provisions, stores, ammunition, and 2,000 tons of coal on board	25 ft. 6 in.
Corresponding displacement	13,500 tons.

ARMAMENT.

Main battery	4 12-in. B. L. R. 14 6-in. R. F.
Secondary battery	20 6-pdr. R. F. 6 1-pdr. R. F. 4 Gatlings. 1 field gun.
Height of axis of forward 13 in. guns above the 23 ft. 10¼ in. L. W. L	26 ft. 1½ in.
Height of axis of after 13 in. guns above the 23 ft. 10¼ in. L. W. L.	18 " 7½ "
Mean height axis 6 in. guns main deck above the 23 ft. 10¼ in. L. W. L.	15 "
Mean height axis 6 in. guns upper deck above the 23 ft. 10¼ in. L. W. L.	22 " 4½ in.

ARMOR.

Water line belt, thickness amidships:	
To 1 ft. below 23 ft. 6 in. L. W. L.	12 in.
Bottom	8½ "
Height above 23 ft. 6 in. load line	[illegible] ft. 6 in.
Total depth of belt	7 " 6 "
Side armor above main belt, thickness	5½ in.
Superstructure armor, "	6 "
Turret armor (13 in. guns), "	17 and 15 in.
Barbette armor, "	15 and 10 "
Protective deck armor "	2¾ to 4 "
Conning tower armor, "	10 in.

GENERAL SCHEDULE OF WEIGHTS.

Hull and fittings	4,836 tons.
Armor and bolts	2,933 "
Protective deck armor	600 "
Armament and ammunition	1,058 "
Machinery, with water	1,396 "
Equipment	199 "
Outfit and stores	478 "
Coal	1,000 "
Total	12,500

MACHINERY.

Vertical, inverted cylinder, direct-acting triple expansion engines, in two watertight compartments.

Collective I. H. P. of propelling, air pump, and circulating pump engines	16,000
Number of revolutions at this power	126
Diameter of high pressure cylinder	38½ in.
Diameter of intermediate cylinder	59 "
Diameter of low pressure cylinder	92 "
Length of stroke	42 "
Cooling surface, main condenser	9,600 sq. ft.
Cooling surface, auxiliary condenser	800 " "

BOILERS.

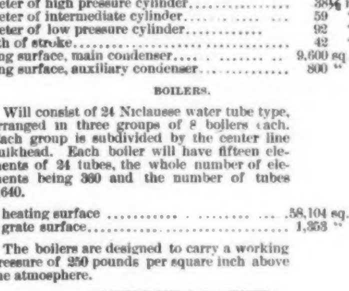
Will consist of 24 Niclausse water tube type, arranged in three groups of 8 boilers each. Each group is subdivided by the center line bulkhead. Each boiler will have fifteen elements of 24 tubes, the whole number of elements being 360 and the number of tubes 8,640.

Total heating surface	58,104 sq. ft.
Total grate surface	1,353 " "

The boilers are designed to carry a working pressure of 250 pounds per square inch above the atmosphere.

NEW FORM OF CAPILLARY ELECTROMETER.

G. VANNI has designed, says the English Electrician, a form of capillary electrometer which is particularly well adapted for school use.



It consists of a tank containing a layer of mercury at the bottom, surmounted by a 30 per cent. mixture of water and sulphuric acid. A capillary thistle tube is vertically inserted in the acid and mercury is poured in at the funnel. The mercury flows out at the bottom until the proper hydrostatic pressure is attained, when it forms a good junction with the acid. E.M.F.'s of a few 10,000ths of a volt can be placed in evidence on the screen, and when larger values are to be dealt with, wider tubes may be employed.

Paris has lost a curious institution, the last of the "cabinets de lecture" in the Passage de l'Opéra having been closed. For a small fee people could enter and read the magazines and latest books. The business was killed by the increased publication of "feuilletons" in the daily newspapers.

THE WATTS-COLLIER ROPE HAULAGE CLIP.

THE rope haulage clip illustrated below is so simple as hardly to need any description, and has the promise of long life and efficiency. It is adapted both for over haulage and under haulage, the former design, however, being the one illustrated. The jaws are shown open in the left hand view; it will be seen that one has a stem designed to fit into a socket hole in the end of the tub. In this stem there is a self-locking pawl, which automatically prevents the stem from escaping from the hole; this pawl must be pressed inward before the clip can be released from the tub. The second jaw is pivoted to the first, and is made to grip the rope by the insertion of a wedge between the two. This wedge is operated by a hand lever, which, when the clip is closed, occupies the position shown in the right hand figure. The clip can be automatically attached to or detached from the rope at any given point by means of striking levers fixed in the "way." The wedge gives a large latitude of grip, and it is stated that the grip will maintain its hold on a rope all the time it is wearing for a diameter of 1 inch to ½ inch. The inventors are Mr. Horace G. Watts and Mr. J. A. M. Collier, of 2 Cotfield Terrace, Gateshead-on-Tyne.—Engineering.

THE WATTS-COLLIER ROPE-HAULAGE CLIP.

AUTOMOBILE TRAVELING VEHICLES.

THE development of automobile traction now permits of realizing two factors that have hitherto been impossible—speed and comfort; and this has led manufacturers to study some types of automobile vehicles of which we desire to say a few words. At the Salon du Cycle of 1896 there was exhibited a large coach in which a very wealthy gentleman proposed to travel through southern Russia. It was a large carriage, with two compartments, which was entered at the rear and was hauled by a Dion-Bouton steam carriage of 35 horse power that permitted of making an average run of 8½ miles an hour at an expense of about three cents a mile.

This same system has been adopted in the large road vehicle of which M. Jeantaud finished the construction some time ago (Figs. 3 and 4). This vehicle is 26 feet in length (or 38 feet inclusive of the locomotive) and 13 in height. The width of the body is 8¼ feet and the weight of the whole, exclusive of the locomotive, is 8,800 pounds. Two-thirds of this weight are carried by the rear axle. The vehicle, with its locomotive, weighs about 7½ tons.

From the plan and section given in Figs. 3 and 4 it will be seen that the carriage is divided into three compartments: (1) in the rear, a kitchen with two cots for the servants and a trap in the floor to give access to the coal and wine bins; (2) in the middle, a toilet room, bath room, and water closet; and (3) in front a large saloon serving as a dining room and sleeping apartment.

On one side of this compartment there is a door giving access to the exterior, while on the other side there are two sofa bedsteads, such as are used upon certain boats. This saloon, which is 14¾ feet in length by 7¼ in width, is, through movable partitions, converted at night into two bedrooms, to which access is had by a lateral passageway. Upon the roof there are three seats upon which the travelers may sit in order to obtain a view of the surrounding scenery. Behind these seats there is a space reserved for baggage. In the rear there are two reservoirs for supplying the kitchen and bath room with hot and cold water. The hot water is furnished by a thermo-siphon, which passes into the kitchen range. Beneath the body are the coal bins and compartments for the reception of various accessories.

The construction of this carriage has been specially studied, and its interior finish in varnished oak and mahogany is most elegant.

There is another system of automobile vehicle under construction, and which has been elaborated by the Scotte Société des Voitures à Vapeur. This is, properly speaking, a train, since it consists of two carriages which, as regards aspect and dimensions, are analogous to the omnibus vehicles constructed by the same establishment (Fig. 1).

As shown in the plan in Fig. 5, the mechanical portion (boiler, engine, etc.) is arranged in the forward carriage or car. Communicating with the front platform there is a small room for the trainmen containing two superposed hammocks. Under the lowermost of the latter is arranged the water reservoir.

In the back part of this first carriage, and without communication with the front, there is a kitchen heated by steam from the boiler. The dining room is formed by the platforms of the two vehicles, which are properly jointed. The folding tables and seats are usually stored away upon one of the sides of the platform. This dining room, which is used only in fine weather, is protected from the sun and wind by curtains.

The second carriage consists of a saloon 13 feet in length by 6¼ in width, which serves as a dining room when it rains, and which at night is converted, through a movable partition, into two bed rooms containing two sofa bedsteads and a folding bed.

At the rear end of the train, on each side of a door, there are arranged a toilet room with a bath tub, a water closet, and wardrobes. These two carriages are ventilated by means of windows on the roof. The interior, which is hung with Lincrusta-Walton, has the aspect of that of a sleeping car. Beneath the body are suspended frames for carrying baggage, provisions, and various other objects.

As the length of each vehicle is 19½ feet, that of the entire train is 39 feet. The width of the body of the vehicle is 6¼ feet and its total height is 11. The weight of the first carriage, with the mechanism and the supply of coal and water, is 5⅕ tons. The second carriage weighs 2¾ tons in running order, say a total of 8 tons. The average speed anticipated is from 8¾ to 9¾ miles an hour.

As for the cost of such vehicles, that varies from $5,000 to $8,000, according to the style in which they are gotten up. This is, perhaps, one of the reasons that

FIG. 1.—SCOTTE AUTOMOBILE TRAIN.

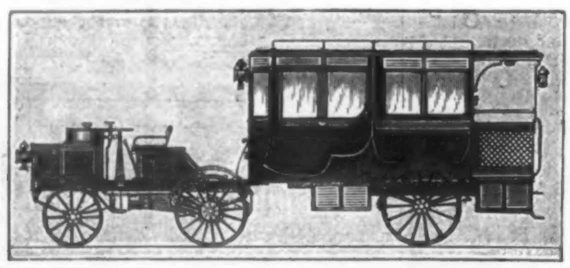


FIG. 2.—THE PRINCE OF OLDENBURG'S COACH.

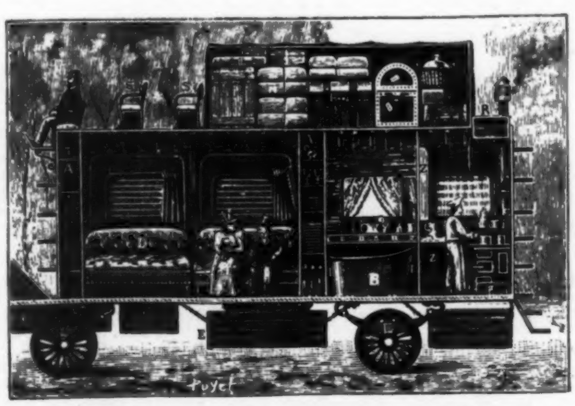


FIG. 3.—THE JEANTAUD AUTOMOBILE TRAVELING CARRIAGE.

A A, closets for clothing and table utensils; D, sofa beds; E, folding foot step; F, kitchen range; R, water reservoir; S, roof seats; Z Z, beds for servants.

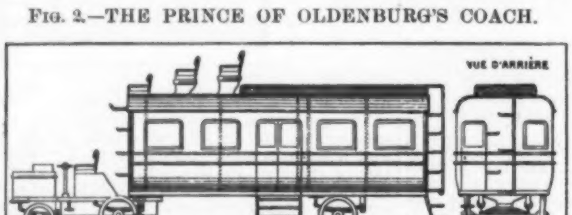


FIG. 4.—ELEVATION AND PLAN OF THE JEANTAUD AUTOMOBILE CARRIAGE.

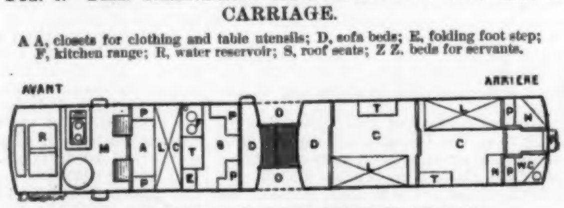


FIG. 5.—PLAN OF THE SCOTTE TRAIN.

A, engineer's apartment; P, cupboards; L C, hammocks; B, kitchen; F, range; T, tables; E, sink; C, sleeping apartments; L, sofa beds; H, toilet room; W C, water closet; M, motive apparatus; N, folding bed; O D, dining room; R, coke bin.

will prevent the common adoption of them, for there are few persons who will be disposed to purchase at such a price a means of saving hotel and railway expenses.—La Nature.

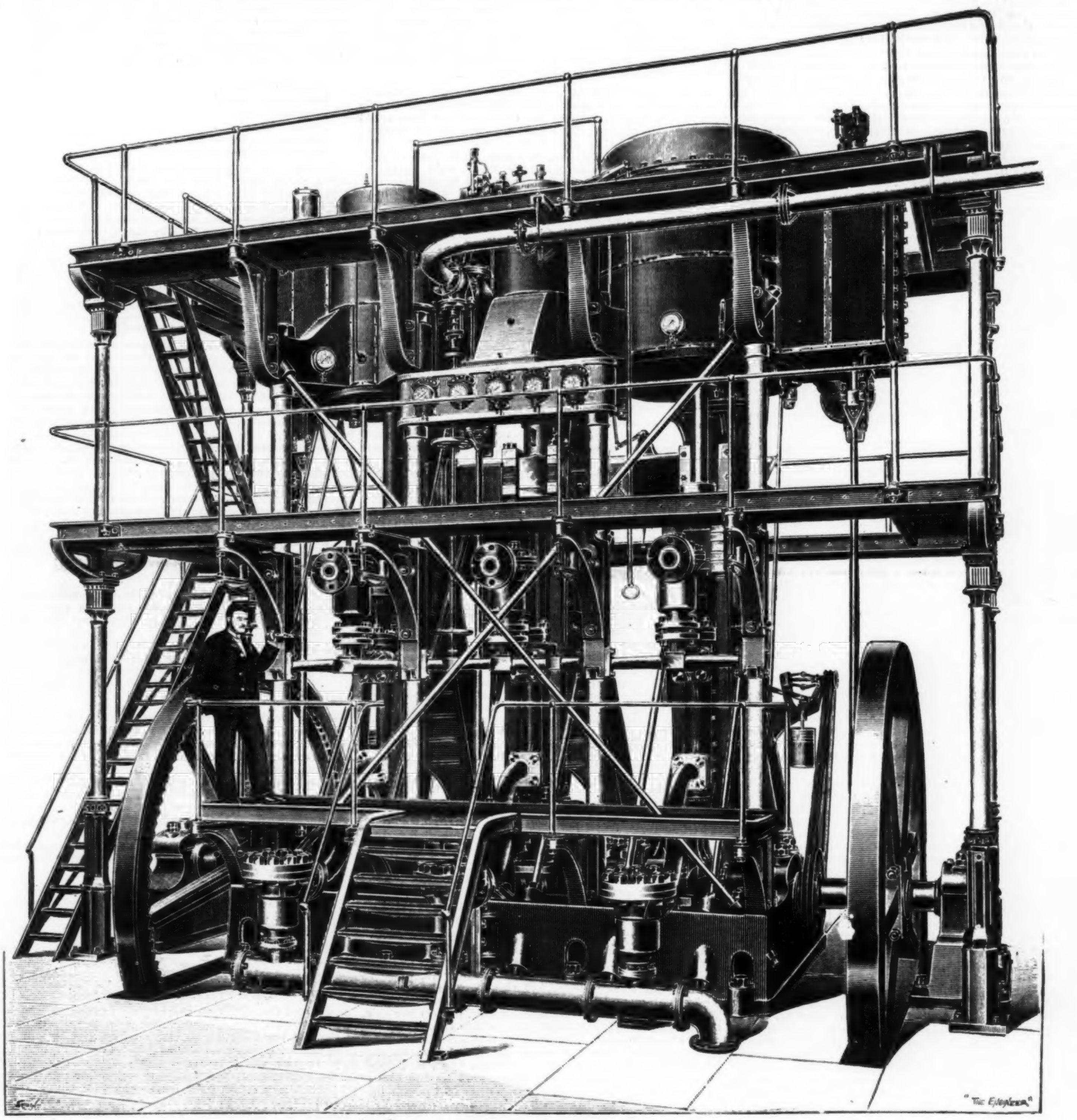
A LARGE HYDRAULIC PUMPING ENGINE.

ONE of the largest pumping engines of its kind has recently been constructed to the order of the Tasmania Gold Mining Company by Messrs. Easton, Anderson & Goulden, Limited, Erith. The purchasers wished to increase the depth of their existing shaft from 718 feet to 918 feet, and had to resort to increased pumping power. The difficulty in fixing a new engine was that the shaft would not admit of another set of spear rods being utilized. Furthermore, the purchasers wished to make use of a spare set of pumps which were in their possession. Messrs. Easton, Anderson & Goulden submitted two schemes, in both of which a motor was fixed at the 718 foot level, working by means of spear rods the pumps at the lower level, and driven from an engine at the surface. One of these schemes was for electric transmission and the other for hydraulic—the latter being accepted. The new engine house is some distance away from the shaft, and the water is carried to the hydraulic motor in the shaft through solid drawn steel piping, and the exhaust is returned to the suction tank at the engine house.

The engine, illustrated by the engraving above is of the usual triple expansion, inverted cylinder type, having cylinders 25 inches, 40 inches, and 69 inches diameter by 42 inch stroke, the pumps being placed directly below the crosshead and in line with the piston-rod. This is shown in the engraving. The crossheads are provided with two gudgeons and are connected to the crank shaft by double connecting rods of rectangular section. The crank shaft is built up and made in two pieces bolted together by a coupling for facilitating transport. The cylinders at the back are supported on massive cast iron frames, of box section, which also carry the pumps. The intermediate pressure and low pressure cylinders are each supported on two steel columns in front. The two middle columns are connected by a cast iron box girder, which carries the front side of the high pressure cylinder, and the three cast iron columns at the back are connected by distance pieces. The cylinders are entirely separate, so as to allow of free expansion, and are jacketed throughout; the high pressure is fitted with a piston valve with internal expansion valve; the intermediate pressure is fitted with a flat slide valve with an expansion valve on the back; and the low pressure cylinder is fitted with a double-ported slide valve. The intermediate pressure and main valve and the low pressure valve are supported by balance cylinders on the top, so as to reduce the stress on the eccentric rods. The pumps and valve boxes are of cast steel, with phosphor bronze rams and valves and seats, and are of massive construction. The bed plate is cast in halves, bolted together, and is of massive box section. As the thrust on the guides came rather high up on the back columns, the latter are supported by diagonal tie rods from the front of the bed plate. The front columns are also braced diagonally to prevent vibration. The engine is provided with a large flywheel on each side. The starting gear and all cocks are arranged to be worked from the lower platform, and may also be worked from the second platform.

A complete system of lubrication is arranged for continuous working. The engine is fitted with a throttle valve, which is shut by a knock-out governor when the speed exceeds the fixed maximum, it is also shut when the accumulator on the main reaches its top position. In case the main should burst, the valve is also shut by a weight which is normally held up by a small plunger connected to the delivery pipe. It will be seen that the three platforms fixed round the engine give easy access to all the parts. Steam at 170 pounds pressure is supplied from four Cornish multitubular boilers, 6 feet 3 inches diameter and 20 feet long, by the same builders. A surface condenser with air and circulating pumps, driven by a small horizontal engine, is to be fixed behind the engine. Provision is also made for exhausting into the atmosphere if necessary. It should be stated that the water is delivered from the pumps at a pressure of 2,100 pounds per square inch.

We are indebted to London Engineer for the engraving and description.



HYDRAULIC PUMPING ENGINES FOR TASMANIA.

The packing of the American cotton bale is again causing trouble abroad, regardless of the repeated warning of American consuls on this head. Reports from Liverpool say that English companies are refusing to insure against loss from "wet and mud damage" due to loose and badly packed bales of American cotton. It is estimated that the claims arising from cotton thus damaged and delivered at Liverpool during the last season will aggregate $500,000. The English insurance companies sent an agent to the United States to investigate the cause, and the blame is placed partly upon the producer and partly upon the transportation companies. A closer and better woven covering is urged; but the chief requisite seems to be greater care in both packing and transport, and some decrease in the belief that foreign nations must take our cotton "any how." Indian and Egyptian cotton is an active competitor, and the splendid condition in which cotton from these countries arrives in England is in very sharp contrast with our own.

ELECTRICAL NOTES.

Mr. F. Lecomte describes in L'Electricien a method of accurately ascertaining the fall of potential in a line or circuit in which there is frequent alteration in pressure. This method consists in having two voltmeters, one at each end of the line. The circuit is then interrupted at the generator end. The voltage is read at that end at the time of break, and the observer at the further end of the line takes the interruption as a signal to record the reading on his voltmeter. The method is simple, but the necessary interruption is the faulty part of the idea.

The Siemens & Halske Electric Company, of America, is considering a proposition from the Japanese government to form in Chicago a syndicate with a capitalization of about $10,000,000, to install and operate all electric street car lines and incandescent lighting and electric power plants which are to be established in the domain of the Mikado as another step in the modernizing movement in progress there. The franchise to be granted is exclusive, and would be one of the most valuable, if not the most valuable, permits ever granted to one syndicate or corporation.

Zinc has been substituted for lead, as the anode of some accumulators. It has given an increased E.M.F., and, due to the reduced weight, an increased specific capacity. Zinc, however, dissolves when the circuit is open and cadmium has been substituted for it. In the Werner accumulator the electrolyte is a solution of the mixed sulphates of zinc, cadmium, and magnesium. The accumulator has a capacity of 82 watt-hours per kilogramme of plates, or 36 watt-hours per kilogramme of total weight. The current is 12 to 15 amperes. The E.M.F. is 2·4 volts at the start, but falls off to 1·9 volts at the end.

The London Electrical Engineer makes the sensible suggestion that the lights in an electricity supply station should be wired from an independent source whenever practicable. In this way an accident resulting from the shutting down of the station would not leave it in darkness. In the Shoreditch station the lights are connected to the storage battery independently of the main switchboard, but this method of connection is only useful where there is an accumulator. In case of the bursting of a steam pipe, for instance, the plant would be left in darkness under ordinary conditions at the very time when light is most urgently needed. This detail is one of great importance, as many stations are entirely dependent upon their own operation for light. Would it not be a good idea to pipe city stations for gas and introduce fixtures for emergency use? The suggestion seems a step backward, but it is nevertheless a practical one.

An electric railway train service has been put into operation between Berlin and Zehlendorff, 7·5 miles distant, says The Mechanical Engineer. The train is made up of nine carriages of the type used on the Berlin elevated railway, weighing 210 metric tons. The carriages at the head and rear of the train are equipped with electric motors, and one or the other hauls the train, according to the direction of motion. All shifting of cars at terminal stations is thus avoided. The run occupies twenty-seven minutes, including four stops, and there are fifteen trains a day each way. Each motor car is equipped with two electric motors of 100 horse power, mounted over the two end axles. The two motor cars are so connected, electrically, that both may be used in case of need, and the four motors may be employed in braking. Besides the electric brakes on the motors, all the carriages in the train are equipped with electromagnetic and Westinghouse brakes. The current is distributed by the third-rail system at a tension of 550 to 600 volts.

The largest dynamo in the world is now being constructed by the Walker Company, of Cleveland, O., for the Boston Elevated Railway, Boston, Mass., says Engineering News. This generator will have an output of 3,000 kilowatts at 550 volts, or about 4,000 horse power. Its speed will be between 75 and 80 revolutions per minute, its total weight 250,000 pounds, and the diameter of the circular cast steel field frame 21 feet 7 inches. The weight of this ring without field magnets will be 25 tons. There will be 24 inwardly projecting laminated cores and pole having a combined weight of 15 tons. The armature hub is 13 feet in diameter and is in two parts, each of which weighs 10 tons. The shaft is 37 inches in diameter. The armature laminations add 15 tons and the armature will have in all 594 slots. The commutator will be 105 inches in diameter and will have 1,188 bars. To facilitate regulation and remove a portion of the strain from the shaft, the flywheel will be bolted directly to extensions on the armature hub. If this machine were to run at the speed of the Niagara generators, 300 revolutions per minute, it would have an output of 16,000 horse power.

J. Trowbridge has lately increased the number of condensers in his transforming apparatus to 120, and obtained the unprecedented E.M.F. of 3,000,000 volts. The behavior of air under this electrical stress is very interesting. Its initial resistance is greatly reduced, and the curve expressing the relation between spark-length and electromotive force departs from a straight line beyond 1,200,000 volts, and approaches the voltage axis. Thus the extreme length of the spark in air obtained with 3,000,000 volts is 6½ feet; whereas a length of at least 10 feet should have been attained if the proportionality between spark length and voltage had been maintained. This departure from proportionality is due to the increased conducting power of the air: for a powerful brush discharge is seen to proceed from the terminals of the apparatus to the floor and the walls of the room. In spite of special precautions, a portion of the discharge was always shunted, so to speak, through the surrounding air. The spark preferred to leap through three or four inches of air to passing through 1,000 ohms of sulphate of copper between terminals of copper one square cm. in area. It is probable that with still higher voltage the initial resistance of the air would still further diminish, and would be of the order of metals. The initial resistance, too, of highly rarefied media diminishes in a similar manner. Thus a Crookes tube which resists the passage of an 8-inch spark is brilliantly lighted by a difference of potential of 3,000,000 volts, and one discharge of a millionth of a second is sufficient to obtain a photograph of the bones of the hand.—Trowbridge, Phil. Mag., August, 1898.

MISCELLANEOUS NOTES.

London has taken up the experiment of municipal street railroads. The South London tramways have been bought by the County Council for $4,250,000.

On Sunday, November 6, there was a violent explosion in the Capitol building at Washington, supposed to have resulted from leakage of illuminating gas. The explosion occurred in the basement beneath the Supreme Court Chambers, and a fire was started which destroyed the furnishings of the chamber. Some damage was done to the congressional law library, mostly, however, by water thrown by the fire department. Contrary to early reports, the important documents of the court were not lost.

After the many centuries during which the forests of Bohemia have furnished fuel and building material for a dense population, it is said that they retain nearly their primeval area. This is due to the forethought of the government in ordaining that as trees are cut down, others shall be planted to fill the vacancies. The wood is mostly pine. Trees are constantly being cut, but wherever a clearing is made, small trees are planted the next spring. These new trees are raised from the seed in small inclosures scattered in the mountains, and are thence transplanted.

A grain dust explosion, on September 23, wrecked the granary of the Eastern Distilling Company at Blissville, Long Island, caused the death of one man and injured four others. The granary was three stories high, built of brick and timber, with wooden partitions covered with corrugated iron. The force of the explosion, says The Engineering News, blew parts of the building 100 feet into the air, and buried part of the Long Island track with wreckage and twisted machinery, and flames spread like a flash through the steam grain conveyor connecting the granary with the docks.

If avoirdupois were the test of greatness, the place of honor would be filled by Maurice Canon, a native of the small frontier town of Stein, in the state of Constance. This man is said to weigh no less than fifty stone, and may claim to be the heaviest man on earth. He measures over one hundred inches round the waist and sixty-four round the thigh; his enormous weight does not apparently inconvenience him, for he is active and in robust health. He is a well-to-do middle-aged farmer, and though his gigantic proportions naturally make him an object of curiosity to his neighbors, he has declined all offers to stray from his native fields.—Humanitarian.

For fifteen years two clever decorative sculptors have been at work on a large model of the Church of the Sacré Cœur at Montmartre, Paris, which is intended for the 1900 Exhibition, says The Builder. It is to $\frac{1}{25}$ the scale of the building, and reproduces all the details minutely in the form of a longitudinal section. The most important part of the work is now completed; only the central dome and the large campanile remain to be added from the drawings, as this portion of the work is not yet actually complete on the building. The tower in the model will reach four meters, or a little over 13 feet, in height. The model is said to be a masterly work of its kind.

A new process of mercerization of woven cotton tissues consists in passing the fabric to be mercerized between two rollers, the lower one being hollow and covered with perforations. The alkaline liquid is placed inside the cylinder, and comes into contact with the goods through the perforations. There is thus, says The Textile Colorist, a steady pressure during the process, due to the weight of the upper roller, and it is claimed for the process that the silky appearance which it imparts to the fiber is not only superior to that obtained in the ordinary way, but it is not affected by any subsequent bleaching, dyeing, or printing that the fabric may have to undergo.

There are some three hundred mica mines at work in the locality of Hazaribagh, Gaya, and Monghyr, and the mica from this district, known commercially as Behar mica, constitutes more than one-half the world's consumption. Moreover, the amount available is stated to be practically inexhaustible. The output last year amounted to nearly 2,000,000 pounds, of which about one-half was exported from Calcutta, chiefly to Great Britain and the United States. The exported mica was valued at Rs. 10,00,000, and that retained for home consumption, chiefly inferior kinds, at Rs. 1,00,000. The mineral is hard and tough and of a clear ruby color, and answers well for furnace work where intense heat has to be withstood.

A great salvage operation is about to be attempted in the Baltic Sea. Last summer the Russian ironclad "Hangöudd," while engaged in maneuvers, went to the bottom near Wiborg, off the Finnish coast, after striking on a concealed rock not marked on the chart. The wreck now lies in 96 feet of water, flat on her side, the bottom being soft mud, into which the vessel has sunk about 20 feet. The Neptun Salvage Association, of Stockholm, offered to raise the vessel for the sum of 950,000 rubles, on the condition that, if the attempt failed, the cost of the operations to the extent of 1,000,000 kroner (nearly two-thirds of the contract sum) should be reimbursed to the association. This offer has been accepted by the Russian government, and the preliminary work has already commenced.

The chemical composition of coal gas and water gas is essentially the same; that is to say, the same constituent gases enter into the composition of each mixture, but the relative proportions vary. The figures given are of actual analyses, but are fairly representative of each class:

	Coal gas. Per cent.	Water gas. Per cent.
Benzene vapor	0·50	0·6
Heavy hydrocarbons	4·25	12·8
Carbonic oxide	8·04	30·7
Hydrogen	47·04	32·4
Marsh gas	36·02	13·9
Higher paraffines	0·00	2·4
Carbonic acid	1·60	2·7
Oxygen	0·39	0·7
Nitrogen	2·16	3·8
	100·00	100·00

—The Engineer.

SELECTED FORMULÆ.

Metal Polish.—For general use in polishing metals, prepared chalk is a good substance; rotten stone, tripoli, and emery are also commonly used agents. For the finest work, jewelers' rouge is employed. This is prepared by calcining precipitated ferric oxide until it assumes a scarlet color.

Substances like emery are most useful for the harder metals, as they scratch too much to be used to any extent on gold or silver. All should be run through a fine sieve before being used.

These various substances, used for polishing metals, are made into pastes, when that form is desired, by being mixed with oleic acid, lard oil, or other fatty vehicle. If the grease should in any case prove objectionable, it is quite probable that glycerin could be substituted for it with satisfactory results.

There have been many formulas published for producing polishing "pomades" for use on metal. It is said that a well-known article, sold as "putz pomade," consists of Armenian bole with sufficient oleic acid to form a paste, and oil of bitter almond to impart an odor. The term "putz," it may be explained, is from putzen, the German for "cleaning" or "polishing."

"Putz tablets" may be made by this recipe:

	Parts.
Soap, cut fine	16
Precipitated chalk	2
Jewelers' rouge	1
Cream of tartar	1
Magnesium carbonate	1
Water, a sufficient quantity.	

Dissolve the soap in the smallest quantity of water, over a water bath. Add the other ingredients to the solution while still hot, stirring all the time to make sure of complete homogeneity. Pour the mass into a box with shallow sides, and afterward cut into cubes.

Polishing pastes may also be made as follows:

		Parts.
I.	Rotten stone	1
	Iron subcarbonate	3
	Lard oil, a sufficient quantity.	
II.	Iron oxide	10
	Pumice stone	32
	Oleic acid, a sufficient quantity.	

Sometimes it is desirable to have a liquid polish for metals. Properly speaking, there can be no such thing, as the polishing process depends, as we have already pointed out, on the attrition of fine particles of some substance a little harder than the metal. The powders used can be, and frequently are, employed in a moist condition, and they may be suspended in water by shaking. A mixture of whiting and ammonia water is frequently used in cleaning metals, the ammonia acting as a solvent of some kinds of dirt. It is best, however, to remove grease, etc., before beginning the polishing process, and the effects of strong alkalies on the hands are not pleasant. The following may be taken as a working formula for a polish of this type:

	Parts.
Prepared chalk	2
Water of ammonia	2
Water, sufficient to make	8

To be well shaken before using.

It is true that the acids, by their chemical action, remove rust and dirt from metallic surfaces without the aid of any of these hard, fine powders, but they generally remove also a portion of the metals themselves each time that they are applied. A weak solution in water of any of the strong mineral acids, or even of citric or oxalic acid, might be found useful in a number of instances, but could not be recommended for general use.—Druggists' Circular.

Stains for Wood.—Rich purple. Boil 2 ounces of fresh logwood powder in 3 pints of rain water until the bulk has lost about 8 ounces by evaporation, then add, a little at a time, sufficient sulphate of indigo to give the shade required.

Yellow.—Make a solution of aniline yellow in alcohol of the requisite depth, and apply with a soft brush. By first applying a weak mahogany stain and then following it with an aniline yellow, a fine orange is secured.

Mahogany.—First rub the surface of the wood with a solution of nitrous acid, and then apply, with a soft brush, the following:

Dragon's blood	1 ounce.
Sodium carbonate	6 drachms.
Alcohol	20 ounces.

The foregoing should be filtered before use.

Blue.—Place the following ingredients in a clean glass jar:

Sulphuric acid	4 ounces.
Indigo (powdered)	1 "

and stand the jar in an earthenware pan, lest they boil over. When the effervescence has ceased, add sufficient of the mixture to clean rain water as will give the requisite shade on a trial slip of wood. Then apply to the work, using a clean bristle brush. The color is much improved by keeping before use.

Green.—In order to secure diversity of shades, make two solutions as follows, and mix in any proportion preferred, remembering that the indigo darkens the tint. The most generally used combination will be six parts of A to one part of B:

A.	Verdigris	4 ounces.
	Vinegar	40 "
B.	Indigo	4 drachms.
	Vinegar	20 ounces.

Both A and B will be better if boiled for ten minutes during solution.—English Mechanic.

To Preserve Milk (Aristol, Indianapolis, Ind.).—Notwithstanding that this question has been answered twice within as many months, we will again state that boric acid is an excellent and harmless preservative of milk, and that in the quantities necessary for preservation (i. e., according to the length of time for which it is desired to preserve the milk), its presence cannot be detected either by the sense of taste or of smell. Five grains to the gallon will preserve the milk from one to three days, according to the care exercised in cleansing containers, the temperature, etc.

THE REFRACTION OF ELECTRIC WAVES.*

Two years ago, Prof. Bose, in a communication to the Asiatic Society of Bengal, described some new devices for dealing with electric waves, which did much to bridge over the gulf between electric waves and light waves. One of these was the employment of nemalite, a fibrous variety of brucite, which has the valuable property of absorbing electric waves vibrating in a certain plane and transmitting all waves at right angles to that plane. It thus could be made to do for electric radiation what a plate of tourmaline does for light, except that the directions of absorption and transmission are reversed. Nemalite is therefore a very convenient polarizer and analyzer of electric waves. Tourmaline also acts in the same manner (with planes reversed), but not to any extent comparable with the efficiency of nemalite. The apparatus was subsequently exhibited and worked before the Liverpool meeting of the British Association.

In the present papers Prof. Bose describes some experiments on the refractive index of glass for electrical waves, carried out for the purpose of testing Maxwell's relation $K = \mu^2$, which maintains that the specific inductive capacity for any substance equals the square of its refractive index.

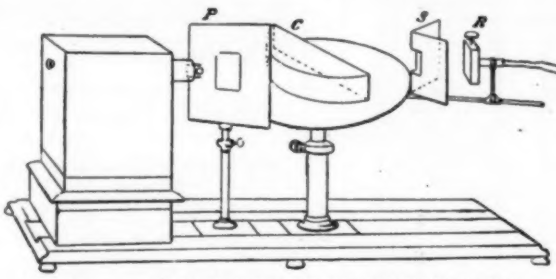


FIG. 1.—THE ELECTRIC REFRACTOMETER.

P, the plate with a diaphragm; *C*, the semi-cylinder of glass; *S*, the shield (only one shown in the diagram); *R*, the receiver.

This relation, originally a purely theoretical deduction from an unproved theory, has been gradually verified as our experimental resources gained in power to grapple with the various difficulties involved in the measurements. In the first place, the specific inductive capacity is not a fixed number, but varies with the nature of the electric charge, whether stationary or alternating, and, if the latter, with the frequency of the alternations. Strictly speaking, Maxwell's relation only applies to the refractive index for waves of infinite length, and determinations of the optical refractive index; i. e., the index for electromagnetic waves of about $\frac{1}{35000}$ of an inch do not bear upon the question. It is only the long invisible electromagnetic waves which can be properly used to test the relation.

TESTING MAXWELL'S RELATION.

The specific inductive capacity of glass has been assigned various values ranging from 2·7 to 9·8. The optical refractive index μ is about 1·5. Prof. Bose determined μ for electric vibrations of a frequency of about 10^{10} vibrations per second. The apparatus used is shown in the diagram.

It closely resembles an optical apparatus. The radiator, consisting of two platinum beads with a platinum sphere between them, and fed by an induction coil, is inclosed in the square box. The rays pass through the diaphragm, *P*, to the semicylinder, *C*, of the glass to be investigated. This semicylinder is turned until the rays are totally reflected by the back surface. They are detected by the receiver, *R*, containing metallic filings, whose resistance is reduced by the impact of the waves. The shielding of the receiver from strong radiations is a matter of some difficulty. Prof. Bose says:

"Another troublesome source of uncertainty is due to the action of the tube which incloses the receiver. When a slanting ray strikes the inner edge of the tube, it is reflected and thrown on to the delicate receiver. Unfortunately, it is difficult to find a substance which is as absorbent for electric radiation as lampblack is for light. Lampblack in the case of electric radiation produces copious reflection. I have tried layers of metallic filings, powdered graphite, and other substances, but they all fail to produce complete absorption. The only thing which proved tolerably efficient for this purpose was a piece of thick blotting paper or cloth soaked in an electrolyte. A cardboard tube with an inner layer of soaked blotting paper is impervious to electric radiation, and the internal reflection, though not completely removed, is materially reduced. No reliance, can, however, be placed on this expedient when a very sensitive receiver is used.

"After repeated trials with different forms of receiving tubes, I found a form, to be described below, to obviate many of the difficulties. Instead of a continuous receiving tube, I made two doubly inclined shields, and placed them one behind the other, on the radial arm which carries the receiver. The first shield has a tolerably large aperture, the aperture of the second being somewhat smaller. The size of the aperture is determined by the wave length of radiation used for the experiment. It will be seen from this arrangement that the rays which are in the direction of the radial arm can effectively reach the receiver, the slanting rays being successively reflected by the two shields. With this expedient, a great improvement was effected in obtaining a definite reading.

"When the deviated rays are convergent, the receiver is simply placed behind the shields, at the focus of the rays. But when the rays are parallel, the use of an objective (placed behind the first shield) gives very satisfactory results. As objectives I used ordinary glass lenses. Knowing the index from my experiments, I was able to calculate the focal distance for the electric ray. This is, of course, very different from the focal distance for the luminous rays. I at first used a lens of 6 cm. electric focal distance, but this did not improve matters sufficiently. I then used one with a longer focus, i. e., 13 cm., and this gave satisfactory results."

The value obtained for μ was 2·04, while the optical refractive index for the D line was 1·53. According to Maxwell's relation, the specific inductive capacity, *K*, should therefore be $4{\cdot}16 = \mu^2$, a value well within the extremes of 2·7 and 9·8 mentioned above. It is interesting to note that the refractive power of glass is higher for these electromagnetic waves than for light, and that ordinary lenses must therefore converge these waves to a shorter focus. Hence the small dimensions of Bose's apparatus.

TOTAL REFLECTION OF ELECTRIC WAVES.

These and some of the earlier experiments were repeated with two semicylinders separated by an air space, and the thickness of air necessary to produce total reflection was determined. In optics, a very thin film of air suffices. In the case of electromagnetic waves as produced in the laboratory, the thickness is found to reckon by several millimeters.

Two semicylinders of glass, with a radius of 12·5 cm., were placed on the spectrometer circle. The plane faces were separated by a parallel air space. The radiator was placed at the principal focus of one of the semicylinders; the rays emerged into the air space as a parallel beam, and were focused by the second semicylinder on the receiver placed opposite the radiator.

The two semicylinders were separated by an air space 2 cm. in thickness; this thickness was found to be more than sufficient for total reflection. The experiments were commenced with an angle of incidence of 30° (slightly greater than the critical angle). The receiver, which was placed opposite the radiator, remained unaffected as long as the rays were totally reflected. But on gradually diminishing the thickness of air space by bringing the second semicylinder nearer the first (always maintaining the plane surfaces of the semicylinders parallel), a critical thickness was reached when a small portion of the radiation began to be transmitted, the air space just failing to produce total reflection. The beginning of transmission could easily be detected and the critical thickness of air determined with tolerable accuracy. The slight discrepancy in the different determinations was due to the unavoidable variation of the sensitiveness of the receiver. When the thickness of air was reduced to 14 mm. the receiver began occasionally to be affected, though rather feebly. But when the thickness was reduced to 13 mm. there was no uncertainty; a measurable, though small, portion of the radiation was now found to be always transmitted.

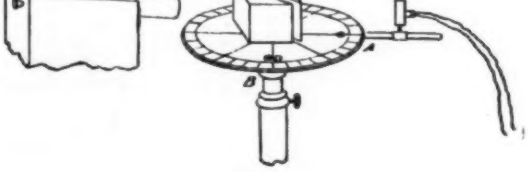


FIG. 2.

L is the lens to render the incident beam parallel; *P*, *P'* are the right-angled isosceles prisms; *A* and *B* are the two positions of the receiver. The receiver-tube is not shown in the diagram.

With an angle of incidence of 60° the minimum thickness for total reflection was found to be between 7·6 mm. and 7·2 mm. The minimum effective thickness is thus seen to undergo a diminution with the increase of the angle of incidence.

The author also determined the influence of wave length, using three different radiators.

The following method of experimenting was adopted as offering some special advantages. If a cube of glass be interposed between the radiator and the receiver placed opposite to each other, the radiation striking one face perpendicularly would be transmitted across the opposite face without deviation and cause a response in the receiver. If the cube be now cut across a diagonal, two right-angled isosceles prisms will be obtained. If these two prisms were now separated slightly, keeping the two hypothenuses parallel, the incident radiation would be divided into two portions, of which one portion is transmitted, while the other portion is reflected by the air film in a direction at right angles to that of the incident ray, the angle of incidence at the air space being always 45°. The transmitted and the reflected portions would be complementary to each other. When the receiver is placed opposite to the radiator, in the *A* position, the action on the receiver will be due to the transmitted portion; but when the receiver is placed at 90°, or in the *B* position, the action on the receiver will be due to the reflected portion. The advantage of this method is that the two observations for transmission and reflection can be successively taken in a very short time, during which the sensitiveness of the receiver is not likely to undergo any great change. In practice three readings are taken in succession, the first and the third being taken, say, for transmission and the second for reflection.

When the prisms are separated by a thickness of air space greater than the minimum thickness for total reflection, the rays are wholly reflected, there being no response of the receiver in position *A*, but strong action in position *B*. As the thickness is gradually decreased below the critical thickness, the rays begin to be transmitted. The transmitted portion goes on increasing with the diminution of the thickness of air space, there being a corresponding diminution of the reflected component of the radiation. When the thickness of the air space is reduced to about 0·3 mm., no reflected portion can be detected even when the receiver is made extremely sensitive. The reflected component is thus practically reduced to zero, the radiation being now entirely transmitted; the two prisms, in spite of the breach due to the air space, are electro-optically continuous. This is the case only when the two prisms are made of the same substance. If the second prism be made of sulphur, or of any other substance which has either a lower or a higher refractive index, there is always found a reflected portion, even when the two prisms are in contact.

The results obtained show that the effective thickness of the air-film increases with the wave length. This was to be expected, since at very small wave lengths, such as those of ordinary light, the thickness required for total reflection becomes very small. The brilliant reflection in the crack of a pane of glass is a familiar example.

* Abstract of two papers communicated to the Royal Society by Prof. Jagadis Chunder Bose, M.A., D.Sc., Calcutta: "On the Determination of the Indices of Refraction of Various Substances for the Electric Ray" and "On the Influence of the Thickness of Air Space on Total Reflection of Electric Radiation." Published in Nature.

COMPANIONS OF ARGON.*

FOR many months past we have been engaged in preparing a large quantity of argon from atmospheric air by absorbing the oxygen with red hot copper and the nitrogen with magnesium. The amount we have at our disposal is some 18 liters. It will be remembered that one of us, in conjunction with Dr. Norman Collie, attempted to separate argon into light and heavy portions by means of diffusion, and, although there was a slight difference† in density between the light and the heavy portions, yet we thought the difference too slight to warrant the conclusion that argon is a composite substance. But our experience with helium taught us that it is a matter of the greatest difficulty to separate a very small portion of a heavy gas from a large admixture of a light gas; and it therefore appeared advisable to reinvestigate argon, with the view of ascertaining whether it is indeed complex.

In the meantime, Dr. Hampson had placed at our disposal his resources for preparing large quantities of liquid air, and it was a simple matter to liquefy the argon which we had obtained by causing the liquid air to boil under reduced pressure. By means of a two-way stopcock the argon was allowed to enter a small bulb, cooled by liquid air, after passing through purifying reagents. The two-way stopcock was connected with mercury gasholders, as well as with a Töpler pump, by means of which any part of the apparatus could be thoroughly exhausted. The argon separated as a liquid, but at the same time a considerable quantity of solid was observed to separate, partially round the sides of the tube and partially below the surface of the liquid. After about 13 or 14 liters of the argon had been condensed, the stopcock was closed and the temperature was kept low for some minutes in order to establish a condition of equilibrium between the liquid and vapor. In the meantime the connecting tubes were exhausted, and two fractions of gas were taken off by lowering the mercury reservoirs, each fraction consisting of about 50 or 60 cubic cm. These fractions should contain the light gas. In a previous experiment of the same kind a small fraction of the light gas had been separated, and was found to have the density 17·2. The pressure of the air was now allowed to rise and the argon distilled away into a separate gasholder. The white solid which had condensed in the upper portion of the bulb did not appear to evaporate quickly, and that portion which had separated in the liquid did not perceptibly diminish in amount. Toward the end, when almost all the air had boiled away, the last portions of the liquid evaporated slowly, and when the remaining liquid was only sufficient to cover the solid, the bulb was placed in connection with the Töpler pump, and the exhaustion continued until the liquid had entirely disappeared. Only the solid now remained, and the pressure of the gas in the apparatus was only a few millimeters. The bulb was now placed in connection with mercury gasholders and the reservoirs were lowered. The solid volatilized very slowly and was collected in two fractions, each of about 70 or 80 cubic cm. Before the second fraction had been taken off, the air had entirely volatilized and the jacketing tube had been removed. After about a minute, on removing the coating of snow with the finger, the solid was seen to melt and volatilize into the gasholder.

The first fraction of gas was mixed with oxygen and

* "On the Companions of Argon." By William Ramsay, F.R.S., and Morris W. Travers. Paper read at the Royal Society, June 16, and published in Nature.

† Density of lighter portion, 19·93; of heavier portion, 20·01 (Roy. Soc. Proc., vol. 60, p. 206).

sparked over soda. After removal of the oxygen with phosphorus, it was introduced into a vacuum tube and the spectrum examined. It was characterized by a number of bright red lines, among which one was particularly brilliant, and a brilliant yellow line, while the green and the blue lines were numerous, but comparatively inconspicuous. The wave length of the yellow line, measured by Mr. Baly, was 5849·6, with a second-order grating spectrum: It is, therefore, not identical with those of sodium, helium, or krypton, all of which equal it in intensity. The wave lengths of these lines are as follows:

Na (D_1)	5895·0
Na (D_2)	5889·0
He (D_3)	5875·9
Kr (D_4)	5866·5
Ne (D_5)	5849·6

The density of this gas, which we propose to name "neon" (new), was next determined. A bulb of 32·35 cubic cm. capacity was filled with this sample of neon at 612·4 mm. pressure, and at a temperature of 19·92° it weighed 0·03184 gramme.

Density of neon.... ....14·67

This number approaches to what we had hoped to obtain. In order to bring neon into its position in the periodic table, a density of 10 or 11 is required. Assuming the density of argon to be 20, and that of pure neon 10, the sample contains 53·3 per cent. of the new gas. If the density of neon be taken as 11, there is 59·2 per cent. present in the sample. The fact that the density has decreased from 17·2 to 14·7 shows that there is a considerable likelihood that the gas can be further purified by fractionation.*

That this gas is a new one is sufficiently proved, not merely by the novelty of its spectrum and by its low density, but also by its behavior in a vacuum tube. Unlike helium, argon, and krypton, it is rapidly absorbed by the red hot aluminum electrodes of a vacuum tube, and the appearance of the tube changes, as pressure falls, from carmine red to a most brilliant orange, which is seen in no other gas.

We now come to the gas obtained by the volatilization of the white solid which remained after the liquid argon had boiled away.

When introduced into a vacuum tube it showed a very complex spectrum, totally differing from that of argon, while resembling it in general character. With low dispersion it appeared to be a banded spectrum, but with a grating, single bright lines appear, about equidistant through the spectrum, the intermediate space being filled with many dim, yet well-defined lines. Mr. Baly has measured the bright lines with the following results. The nearest argon lines, as measured by Sir William Crookes, are placed in brackets:

Reds very feeble, not measured.			
First green band, first bright line	5632·5	(5651 : 5619)	
First green band, second bright line	5583·0	(5619 : 5567)	
First green band, third bright line	5537·0	(5557 : 5320)	
Second green band, first bright line	5163·0	(1565)	
Second green band, second bright line	5126·5	(5165 : 5065)	brilliant.
First blue band, first bright line	4733·5	(4879)	
First blue band, second bright line	4711·5	(4701)	
Second blue band, first bright line	4604·5	(4629 : 4594)	
Third blue band (first order)	4314·0	(4333 : 4300)	
Fourth blue band (second order)	4213·5	(4251 : 4201)	
Fifth blue band (first order), about	3878·0	(3904 : 3835)	

The red pair of argon lines was faintly visible in the spectrum.

The density of this gas was determined with the following results: A globe of 32·35 c. c. capacity, filled at a pressure of 765·0 mm., and at the temperature 17·43°, weighed 0·05442 gramme. The density is therefore 19·87. A second determination, made after sparking, gave no different result. This density does not sensibly differ from that of argon.

Thinking that the gas might possibly prove to be diatomic, we proceeded to determine the ratio of specific heats:

Wave length of sound in air	34·18
" " " gas	31·68
Ratio for air	1·408
" gas	1·660

The gas is therefore monatomic.

Inasmuch as this gas differs very markedly from argon in its spectrum, and in its behavior at low temperatures, it must be regarded as a distinct elementary substance, and we therefore propose for it the name "metargon." It would appear to hold the position toward argon that nickel does to cobalt, having approximately the same atomic weight, yet different properties.

It must have been observed that krypton does not appear during the investigation of the higher boiling fraction of argon. This is probably due to two causes. In the first place, in order to prepare it, the manipulation of air amounting to no less than 60,000 times the volume of the impure sample which we obtained was required; and in the second place, while metargon is a solid at the temperature of boiling air, krypton is probably a liquid, and therefore more easily volatilized at that temperature. It may also be noted that the air from which krypton has been obtained had been filtered and so freed from metargon. A full account of the spectra of those gases will be published in due course by Mr. E. C. C. Baly.

University College, London.

* June 21.—After a preliminary fractionation, the density has been still further reduced to 12·7.

NEW WAVE POWER MOTOR.

OUR engravings illustrate the new wave power motor buoy designed by B. Morley Fletcher, C.E., of England. He has tried many experiments upon the sub-

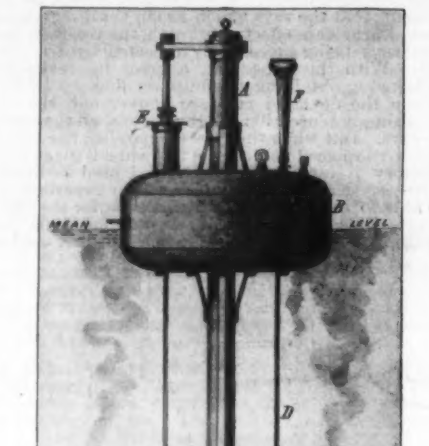


FIG. 1.—THE FLETCHER WAVE POWER MOTOR.

ject, and has successfully launched more than one hydraulic pumping plant, as well as a most ingenious buoy fitted on his system so that the oscillation caused by the slightest movement of the surface of the sea enables the air to be pumped into the reservoir, from which it is utilized to blow a fog-horn, either constantly or at regular intervals. Our first engraving shows the wave power motor. It is secured to the bottom of the sea with the aid of anchors and the mooring attachment, *D*. Four links pass through a single submerged table, *C*, the anchor chain being connected to a ring at the foot. The hydrometer tube, *A*, with the table, *C*, are loaded in such a manner as to take up a level position, which, by means of the resistance to vertical oscillation offered by the table, remains approximately constant. Around this tube, at the surface, the buoy, *B*, is free to oscillate with every movement of the sea waves, storing air by means of the pump, *E*, within the empty buoy, a blast occurring at intervals or constantly at the fog-horn, *F*. The mooring attachment has had a severe test at Bilbao, Spain, and it was found to be entirely satisfactory. In case of a working service apparatus, the upper portion is covered by a wrought iron cone-shaped top, which is waterproof. Gearing is also provided and fitted for determining the nature of the blast of the fog-horn as may be desired. Our second and third engravings show a further modification of this motor. For our engravings we are indebted to our English contemporary Industries and Iron.

HOLDING POWER OF CUT AND WIRE NAILS.

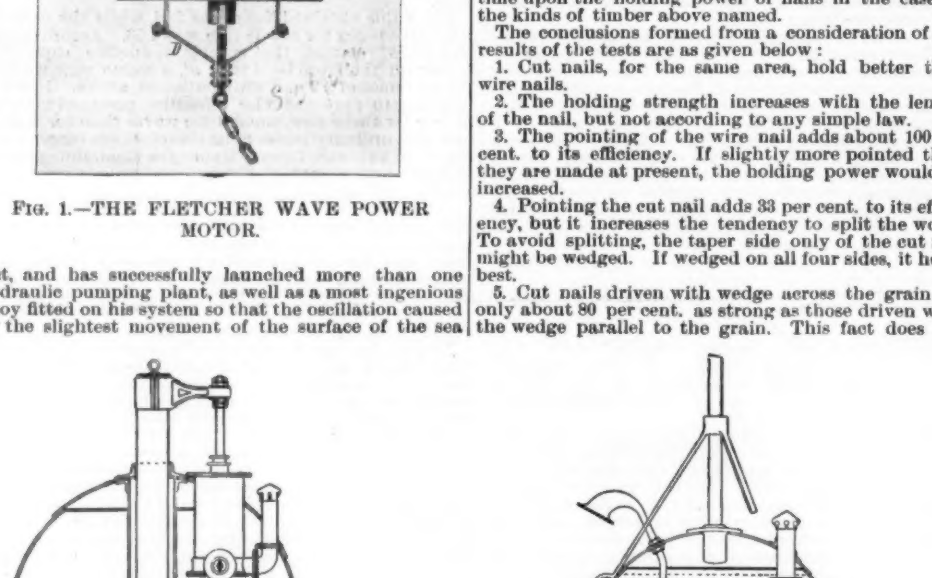
BEFORE the Technical Society of the Pacific Coast, in San Francisco, Prof. Soule, of the University of California, recently read a paper on the holding power of nails, from data obtained by tests with cut and wire nails, driven in Douglas spruce (Oregon pine) and in redwood.

The points which it was particularly desired to clear up by these tests were, says The Mining and Scientific Press:

The relative merits of cut and of wire nails; the merits of different surfaces on the nails; the best shape of nails, as to points, etc.; the relative holding powers of these nails in Douglas spruce and in redwood; the best relation between the length of nail and the thickness of the board nailed by it; the effect of time upon the holding power of nails in the cases of the kinds of timber above named.

The conclusions formed from a consideration of the results of the tests are as given below:

1. Cut nails, for the same area, hold better than wire nails.
2. The holding strength increases with the length of the nail, but not according to any simple law.
3. The pointing of the wire nail adds about 100 per cent. to its efficiency. If slightly more pointed than they are made at present, the holding power would be increased.
4. Pointing the cut nail adds 33 per cent. to its efficiency, but it increases the tendency to split the wood. To avoid splitting, the taper side only of the cut nail might be wedged. If wedged on all four sides, it holds best.
5. Cut nails driven with wedge across the grain are only about 80 per cent. as strong as those driven with the wedge parallel to the grain. This fact does not



FIGS. 2 AND 3.—CABLE-LAYING BUOY, WITH INTERMITTENT AIR BLAST WORKED BY FLETCHER WAVE POWER MOTOR.

accord with practice in driving, probably on account of the greater tendency to split the wood.

6. A nail is three times as strong when driven into the side of a beam—that is, across the grain—as it is driven into the end of it—that is, parallel to the grain.

7. The holding power of nails increases with time in the case of redwood. It is asserted by some that the tannic acid rusts the nail and thus increases its holding power. It is probable that this effect would be extended over a few months only, after which the further rusting of the nail would weaken it. The effect of time in the case of cement nails does not seem to be great, and is only slightly greater in the case of wire nails, but is very considerable for cut nails.

8. The tests show that all these nails lose holding power with time when driven into Douglas spruce. This probably may be accounted for by the small lateral adhesion of the fibers in that wood and their gradual yielding to the wedge action of the nail. In other words, they pinch the nail less with time, but it seems unlikely that this diminution would continue indefinitely.

9. In redwood a cut nail holds slightly better than a wire nail.

10. In Douglas spruce the cut nails are 1.3 times stronger than the wire nails.

11. A cut nail is slightly stronger than a wire nail when driven into redwood, but the difference in strength is small.

12. Under shearing stress cut nails are 1·4 times stronger than wire nails. There seems to be no difference in the resistance of the nails to shear in using blocks of Douglas spruce or of redwood.

13. When nailing cleats to a block, the same area of nail in the wood will hold about the same stress, whether a few large nails are used or more small ones. The superiority, if any, is in favor of the larger nail.

14. The cut nail holds 1·33 better in Douglas spruce than in redwood; the wire nail about the same in each, with a slight superiority in favor of redwood.

15. The holding power of a nail is not directly proportional to its surface in contact with the wood. In determining the relative holding powers, the stress per unit area has been employed, but as far as possible nails have been taken as nearly alike as practicable, so as to eliminate the error introduced by this method.

16. In drawing a nail, the pull seems to reach a maximum shortly after the nail starts.

17. In the case of a wire nail, the applied stress increases gradually; of a cut nail, by jerks and starts. The decrease of holding in wire nails after reaching the maximum is gradual, while in cut nails it falls off suddenly. Hence, a cut nail is not as efficient in holding together pieces of timber subject to vibration as is the wire nail, for the former is more easily loosened, and, being partly withdrawn, loses much of its strength. This results from the fact that the major portion of the resistance comes from the wedge sides of the nail.

18. Cut nails are more likely to split Douglas spruce and wire nails to split redwood.

19. In shearing a cleat from a block to which it is nailed, a maximum resistance is obtained for a cleat the thickness of which is two-fifths of the length of the nail used. This agrees closely with the practice of using a nail about $2\frac{1}{2}$ times the thickness of the thinner piece nailed.

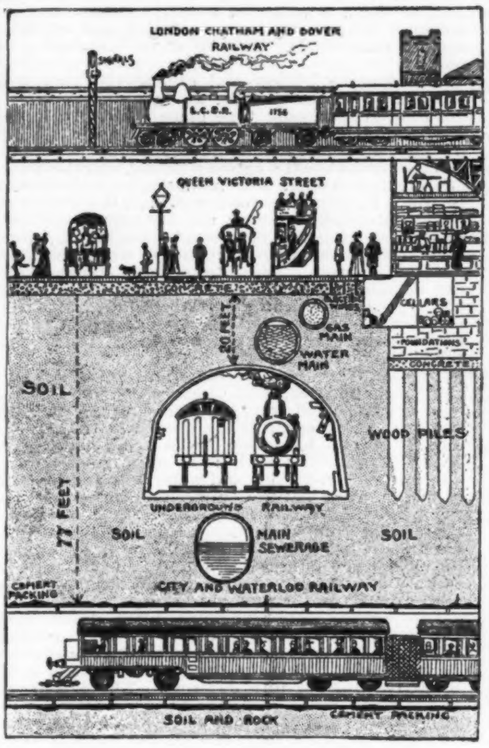
20. A slight roughness on the surface of a nail is of advantage.

21. The cut nail is more efficient when driven into Douglas spruce, but the wire nail is more so in redwood. This fact bears out the theory as to the manner in which a wire nail holds. The lateral pressure of the redwood fibers is greater than that of the fibers of Douglas spruce, on account of the closeness of the grain of the redwood, it having thirty-six annular rings to the inch, as against fourteen for the spruce; and this holds true notwithstanding that the redwood is softer than the spruce.

The general conclusion from the tests was that, for most uses and under most conditions, the cut nail is superior to the wire nail.

A SLICE OF LONDON.

THE London Mail has presented to its readers a curious representation of what it calls the "busiest spot on earth"—the spot, however, being a slice of earth at Slaughter Corner, London. On the surface of this corner converge Queen Victoria Street, New Bridge Street, and the approach to Blackfriars Bridge. Overhead is the elevated structure of the London, Chatham and Dover Railway. Underneath, at depths of 20 feet and 77 feet respectively, below the concrete under the wood pavement, are the roof walls of the Metropolitan Underground and the City and Waterloo Railways, and at varying distances below the surface are the electric wire conduits, water and gas mains, and a main of the sewage system. Taking into account the business houses at the side and below the level of the elevated structure, this may be considered an instance



A SLICE OF LONDON.

of eight-story traffic of which five-eighths is below the surface.

FREIGHT ENGINE DESIGNED BY CORNELIUS VANDERBILT, JR.

A POWERFUL freight engine designed by Cornelius Vanderbilt, Jr., in which are embodied certain personal theories of Mr. Vanderbilt's of locomotive development, has recently undergone a successful test on the lines of the New York Central and Hudson River Railroad Company. We present an engraving of the locomotive, which is known as No. 787, from which it will be seen that, in appearance, the new engine presents no radical departure from the standard type of motive power in use on the New York Central Railroad.

The engine is of the Mogul type, with a boiler of the extended wagon-top type, worked under the steam pressure of 180 pounds per square inch. The smallest ring of the shell is 60 inches in diameter, the fire box is $111\frac{3}{8}$ inches long by $50\frac{3}{8}$ inches wide, and the fire grate has an area of 29·45 square feet. There are 277 flues, each 2 inches in outside diameter and 11 feet 6 inches long. These flues furnish a heating surface of 1655·65 square feet; the total heating surface being 1812·94 square feet. The cylinders are 19 inches in diameter by 26 inches stroke. The driving journals are 8×9 inches, the engine truck journals $5\frac{1}{2} \times 10\frac{3}{8}$ inches, and the tender truck journals $4\frac{1}{4} \times 10\frac{3}{8}$ inches. The driving wheels are 57 inches in diameter, the total weight of the locomotive is 144,670 pounds, the weight of the locomotive and tender loaded is 240,470 pounds.

In the tests of the engine which have been already made, it has proved economical in fuel consumption, and it is capable of handling a load about 40 per cent. greater than the standard type which has hitherto been in use on the New York Central Railroad. It recently hauled a train of 71 loaded grain cars from De Witt, near Syracuse, to West Albany, a distance of about 140 miles, in good average time, and with apparent ease.

FOODS.*

THE functional activity of every organ and tissue of the body is accompanied by a more or less active disintegration of the living material, bioplasm, of which they are composed. The complex and highly unstable molecules of this living material are continually undergoing disruption and falling into less complex and more stable compounds; these, through oxidative processes, are eventually reduced through a series of descending chemic stages to a small number of simpler compounds which, being of no further value to the organism, are eliminated by the various eliminating or excretory organs, the lungs, skin, kidney, liver. Among these excreted compounds the more important are urea, uric acid, and carbon dioxide. Many other compounds, organic as well as inorganic, are also eliminated from the body in the various excretions, though they are present but in small amounts. Coincident with this disintegration of living material there is a liberation of chemical potential energy, which manifests itself for the most part as heat and mechanical work.

In order that the organs and tissues may continue in the performance of their functions, it is essential that they be supplied with nutritive materials similar to those which enter into the composition of their living material, viz.: Proteids, fat, carbohydrates, water, and inorganic salts. These compounds, though originally derived from the food, are immediately derived from the blood as it flows through the capillary bloodvessels. The blood is therefore to be regarded as a reservoir of nutritive material in a condition to be absorbed and transformed into utilizable and living material. Inasmuch as the materials lost to the body daily, through disintegration and oxidation, though considerable, are supplied by the blood, it is evident that this fluid would diminish rapidly in volume, with a corresponding decline in functional activity, were it not restored by the introduction into the body of new material in the food. With the diminution of the volume of the blood and an insufficient supply to the tissues, there arise the sensations of hunger and thirst, which lead to the consumption of food and the subsequent restoration of the physiological condition of the tissues. Those two sensations are also partially dependent on the empty condition of the stomach and the dryness of the mucous membrane of the mouth and throat.

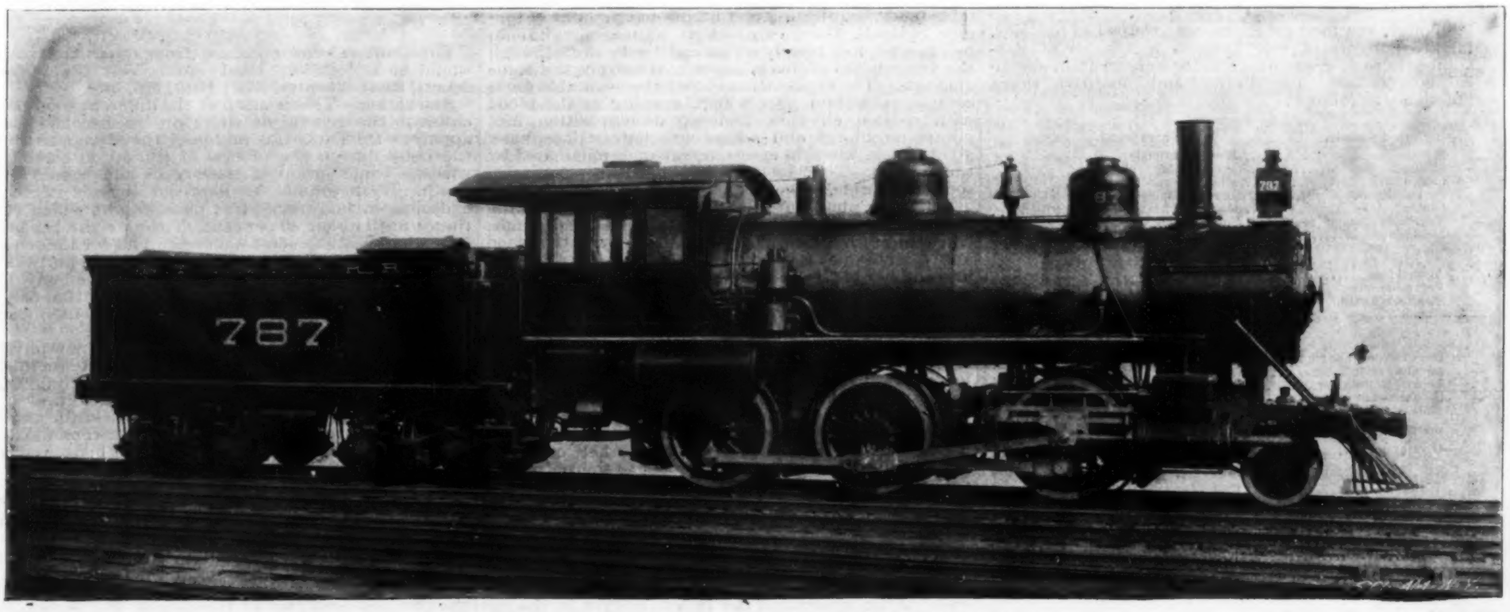
The foods which are consumed daily in response to the sensations of hunger and thirst are complex in composition and contain, though in varying amounts, proteids, fats, carbohydrates, water, and inorganic salts, which, in contradistinction to foods, are termed food principles or nutritive principles. In these compounds is also to be found the potential energy necessary to maintain the dynamic equilibrium of the body and which will become manifest as heat and mechanical work in the transformations of the material underlying the nutritive processes.

The animal body may be therefore regarded as a machine capable daily of performing a certain amount of work, by which is meant the overcoming of an opposing force through a definite distance by the expenditure of a definite amount of energy. In the performance of its work, whether it be the raising of weights against gravity, the overcoming of friction, cohesion, or elasticity, the machine suffers disintegration and loses a portion of its available energy. Unlike other machines, however, it possesses the power, within limits, of self-renewal, self-adjustment, when supplied with foods in proper quantity and quality.

QUANTITIES OF FOOD PRINCIPLES REQUIRED DAILY.

In order that the body may continue in the performance of its work and yet retain a given weight, it is essential that the loss to the body daily shall be exactly compensated by the introduction and assimilation of

* Lecture delivered at the Drexel Institute, Philadelphia, by Dr. A. P. Brubaker. Revised by the author for the SCI. AM. SUPPLEMENT.



FREIGHT ENGINE DESIGNED BY CORNELIUS VANDERBILT, JR.

a corresponding amount of food principles. If this condition is realized, the body neither gains nor loses, but remains in a condition of nutritive equilibrium. The determination of the exact quantities of the different food principles required daily and their ratio to each other is made from an examination of the quantity and composition of the daily excretions. Since the proteids disintegrated are represented in the excretions by urea and similar nitrogen-holding compounds and the fats and carbohydrates by carbon-dioxide, it becomes possible to determine from them the quantities required to restore equilibrium under any given condition. But as the activity of the nutritive changes will vary in accordance with climatic conditions, work done, etc., and as the excreted products will vary in the same ratio, it is obvious that the required amounts of food will vary in accordance with these varying conditions, if equilibrium is to be maintained.

Various estimates have been made by different investigators as to the amounts of the excreted products and the food principles required daily, which, though differing to some extent, have, nevertheless, an average nutritive and energy-producing value. The following table shows the diet scale of Vierordt and the excretions to which it would give rise. As the income and outgo practically balance, there would be no change in the weight.

COMPARISON OF THE INCOME AND OUTGO.

Income.	Grammes.	Ounces.	Outgo.	Grammes.	Ounces.
Proteid	120	4·232	Water	2690	94·80
Fat	90	3·174	Urea	40	1·40
Carbohydrates	330	11·640	Fæces	166	5·85
Salts	32	1·130	Salts	32	1·13
Water	2818	99·30	Carbon-dioxide	922	32·49
Oxygen	756	26·64	Water formed in body	296	10·43
	4146			4146	

Other estimates as to the amounts of the organic food principles required daily are as follows:

	Ranke. Grammes.	Voit. Grammes.	Moleschott. Grammes.	Atwater. Grammes.	Hultgren. Grammes.
Proteid	100	118	130	125	134
Fat	100	56	84	125	79
Starch	250	500	550	400	522

In arranging tables showing the relation between the income and the outgo, it is generally customary to state merely the amounts by weight of the nitrogen and carbon each contains. This method furnishes sufficiently accurate information regarding the metabolism of the body, for the reason that the nitrogen represents the proteid, and the carbon, with the exception of that contained in the proteid, the fat and carbohydrates which have undergone disintegration or metabolism.

The following balance table, as given by Ranke, shows the relation of the nitrogen to the carbon in the average mixed diet and in the excretions of a man weighing 70 kilogrammes, in a condition of nutritive equilibrium:

Income.	Grammes.	N	C
Proteid	100	15 5	53 0
Fat	100	......	79·0
Carbohydrates	250	......	93 0
		15 5	225·0

Outgo.	Grammes.	N	C
Urea	31·5	14·4	6·16
Uric acid	0·5		
Fæces	....	1·1	10·84
CO_2	....	......	208 00
		15·5	225·00

From the above it will be observed that the daily discharge for each kilogramme of body weight is 0 21 gramme nitrogen and 3·03 grammes of carbon. The relation of the two being $\frac{C}{N} = 14·5$. On a diet in which there is an excess of either proteid or carbohydrates this ratio necessarily changes.

CLASSIFICATION OF FOOD PRINCIPLES.

Though the food principles are grouped as proteids, fats, carbohydrates, etc., there is a number of substances in each group which differ somewhat in chemical composition, digestibility and nutritive value. These are as follows:

1.—PROTEIDS.

Principle.	Where found.
Myosin	Flesh of animals.
Albumen, vitellin	White of egg, yolk of egg.
Casein	Milk, cheese.
Serum-albumen, fibrin	Blood contained in meat.
Gluten	Grain of wheat and other cereals.
Vegetable albumen	Soft-growing vegetables.
Legumin	Pease, beans, lentils, etc.

2.—FATS.

Animal fats Vegetable oils	Found in adipose tissue of animals.
Stearin, palmitin, olein, fatty acids	In seeds, grains, nuts, fruits, and other vegetable tissues.

3.—CARBOHYDRATES.

Dextrose or grape sugar Levulose or fruit sugar	Found in fruits.
Lactose or milk sugar	Milk.
Saccharose or cane sugar	Sugar cane, beet roots.
Maltose	Malt and malted foods.
Starch	Cereals, tuberous roots and leguminous plants.
Glycogen	Liver, muscles.

4.—INORGANIC.

Water Sodium and potassium chlorid. Sodium and potassium, calcium phosphates and carbonates Iron	In nearly all animal and vegetable foods.

5.—VEGETABLE ACIDS.

Citric, tartaric, acetic, malic	Fruit and vegetables.

The proteid principles of the food, after undergoing digestion and conversion into peptones, are absorbed into the blood. During the act of absorption they are transformed into the form of proteids characteristic of blood. After being distributed by the blood stream to the tissues, they are brought into relation with their living cells or bioplasm. The disposition made of the proteid material by the bioplasm has not been definitely determined. According to Voit, of the proteid thus brought into contact with the living tissues, only a small percentage is utilized and assimilated for tissue repair. This he terms tissue or organ proteid. The remaining large percentage circulating in the interstices of the tissues, though not forming an integral part of them, is acted on directly by them, merely in virtue of contact—split up, oxidized, and reduced to simpler compounds. This he terms circulating proteid.

According to Pflüger and others, this view is not tenable. He asserts that, as material changes or metabolism can only take place within living cells, all the proteid must first be assimilated and organized by the cells before it can undergo metabolic changes. Metabolism by contact action is denied, and the division of proteids into organ and circulating proteid is not justifiable. In the process of metabolism the proteid suffers disintegration, giving rise through oxidation to some carbon-holding compound, possibly fat, and to some nitrogen-holding compounds, which eventually give rise to urea. The intermediate stages, though not definitely known, are possibly represented by glycin, creatin, uric acid, etc. The disintegration of the proteids is attended by the disengagement of heat, thus contributing to the general store of the energy of the body.

The fat principles, after digestion, are absorbed by the lymphatic vessels and discharged by the thoracic duct into the blood, from which they rapidly disappear. Though it is possible that a portion of the fat enters directly into the formation of the living material, it is generally believed that it is at once oxidized and reduced to carbon-dioxide and water with the liberation of energy. The natural supposition that a portion of the ingested fat was directly stored up in the cells of the areolar connective tissue, thus giving rise to adipose tissue, has been disproved. The body fat, under physiological conditions, is a product of the metabolic activity of connective tissue cells and is a derivative of both proteids and carbohydrates.

The carbohydrate principles, after digestion, are absorbed into the blood as dextrose. This compound is then stored up in the liver and muscles as glycogen. Before being utilized in the nutritive process, it is again reconverted into dextrose. The intermediate stages which dextrose passes through before it is reduced to carbon-dioxide and water are only imperfectly known. Though a large part of the sugar is at once oxidized, it is now well established that another portion contributes to the formation of, if not directly converted into, fat. As the carbohydrates form a large portion of the food, they contribute materially to the production of energy.

The inorganic principles, though not playing apparently as active a part in the metabolism of the body as the organic, are nevertheless essential to its physiological activity.

Water is promptly absorbed after ingestion and becomes a part of the circulating fluids—blood and lymph. In the digestive apparatus it favors the occurrence of those chemic changes in the food necessary for their absorption, it promotes absorption of the food, holds various constituents of the blood and other fluids in solution, hastens the general metabolism of the body, holds in solution various products of metabolic activity, and, leaving the body through the excretory organs, promotes their elimination.

Sodium chloride is absorbed into the blood and, unless taken in excess, is utilized in replacing that which is lost to the organism daily—about 15 grammes. The exact role which sodium chloride plays in the nutritive process is unknown; but, as it is present as a necessary constituent in all the fluids and solids of the body, and as it is instinctively employed as a condiment, it may be assumed to have a more or less important function.

When taken as a condiment, it imparts sapidity to the food and excites the flow of the digestive fluids; it ultimately furnishes the chlorine for the hydrochloric acid of the gastric juice. Judging from the impairment of the nutrition as observed in animals after deprivation of salt for a long period of time, it favorably influences the growth and functional activity of all tissues.

It is well known that herbivorous animals, races of men as well as individuals who live largely on vegetable foods, require a larger additional amount of sodium chloride than carnivorous animals or human beings who live largely on animal foods, even though the two classes of foods contain relatively the same amounts. The explanation is that the vegetable foods contain potassium salts which, meeting in the blood with sodium chloride, undergo decomposition into potassium chloride and sodium carbonate or phosphate, all of which, when in excess, are at once eliminated by the kidneys. The blood, therefore, becomes poorer in sodium chloride, one of its necessary constituents.

Potassium phosphate and carbonate are also essential to the normal composition of the solids and fluids. They impart a certain degree of alkalinity to the blood and lymph, one of the conditions necessary to the life and activity of the tissue cells bathed by them. When administered in small doses, they increase the force of the heart, raise the arterial pressure, and increase the activity of the circulation.

Calcium salts are partly utilized in maintaining the solidity of the bones and teeth, replacing the amount metabolized daily. Inasmuch as the metabolism of these two tissues is slight, there is not much need in the adult for lime as an article of food. In young animals lime is essential to the solidification and development of bone. When deprived of it, the skeleton undergoes a defective development similar to the pathological condition known as rickets. Lime is present in milk to the extent of 1·5 per cent., as well as in eggs and pease in relatively large quantities.

Iron is contained in both animal and vegetable foods, not, however, in the form of inorganic iron, nor in the form of an organic salt, but as a compound with nuclein, thus forming an integral part of the proteid molecule. After absorption the iron is utilized in the formation of the coloring matter of the blood corpuscles—hemoglobin. The organic compounds of iron and the nucleins have been termed hematogens. The amount of iron ingested has been estimated at from 10 to 20 milligrammes, the larger part of which is eliminated in the fæces. The relatively small part eliminated by the kidneys and liver is usually taken as the amount metabolized, though it is probable that this is not wholly true, as there is evidence that iron can be retained in the body and utilized again in the formation of new hemoglobin. Contrary to what might be expected, milk contains but a very small quantity of iron, not more than 3 or 4 milligrammes in 1,000 grammes (human milk)—an amount for the development of the necessary hemoglobin. This is compensated for, however, by the accumulation of iron in the liver during intra-uterine life. According to Bunge, the liver of a newly born rabbit contains as much as 18·2 milligrammes per 100 grammes of body weight, while at the end of twenty-four days it only contains 3·2 milligrammes per 100 of body weight.

The Energy or Heat Value of Food Principles.—The food consumed not only restores the material metabolized and discharged from the body daily, but also the energy which has been expended as heat and mechanical work. The food principles are products of the constructive processes taking place in the vegetable world during the period of growth and activity. At the time of their formation there is an absorption and storing of the sun's energy which then exists in a potential condition. During the metabolism of the animal body these compounds are reduced through oxidation to relatively simple bodies, such as carbon-dioxide, water, urea, etc., with the liberation of their contained energy. All of the energy of the body, whatever its manifestations may be, can be traced to chemic changes going on in the tissues, and more particularly to those changes involved in the oxidation of the food principles.

The amount of heat or energy which any given food principle will yield can be determined by burning a definite amount (e. g., 1 gramme) to carbon-dioxide and water and ascertaining the extent to which the heat thus liberated will raise the temperature of a given amount of water (e. g., 1 kilogramme). The amount of heat may be expressed in gramme or kilogramme degrees or calories, a gramme calorie or kilogramme calorie being the amount of heat required to raise the temperature of a gramme or a kilogramme (1,000 grammes) of water 1° C. The apparatus employed for this purpose is termed a calorimeter, which consists essentially of a closed chamber in which the oxidation takes place and is surrounded with water, the rise in temperature of which indicates the amount of heat produced.

The results obtained by investigators employing different calorimeters and different principles of the same group vary, though within certain limits (e. g., 1 gramme casein yields 5·867 kilogramme calories; 1 gramme of lean beef, 5·656 calories; 1 gramme of fat yields 9·353, 9·423, 9·686 calories; 1 gramme of carbohydrate, 4·182, 4·479, etc., calories).

In the human body as determined by calorimetric methods the oxidation of the food principles yields practically the same amount as they do when oxidized outside the body, with the exception of the proteids, which are only oxidized to the stage of urea. As this compound is capable of further reduction in the calorimeter to carbon-dioxide and water with the liberation of heat, the quantity of heat it contains must therefore be deducted from the estimated heat value of the proteid. According to Rubner, 1 gramme urea will yield 2·523 kilogramme calories. As the urea which results from the oxidation of 1 gramme of proteid is about ⅓ of a gramme, the amount of heat to be deducted from the heat value of the proteid is ⅓ of 2·523 or 841 calories. It has also been shown that some of the ingested proteid escapes in the fæces, the heat value of which must also be determined and deducted. This having been done, the physiological heat value becomes 4·124 calories.

The following estimates give approximately the number of kilogramme calories produced when the food is burned to carbon-dioxide, water, and urea in the body:

1 gramme proteid yields	4·124	calories.
1 " fat "	9·353	"
1 " carbohydrate yields	4·116	"

The total number of kilogramme calories or kilogramme degrees of heat yielded by any of the previously given diet scales can be readily determined by multiplying the quantities of food principles consumed by the above mentioned factors. The diet scale of Vierordt, for example, yields the following:

120 grammes of proteid yields	494·88	calories.
90 " " fat "	841·77	"
330 " " starch "	1358·28	"
	2694·93	"

The total calories obtained from other diet scales would be as follows: Ranke, 2335; Voit, 3387; Moleschott, 2984; Atwater, 3331; Hultgren, 3436.

Starvation.—The relation of the different food principles to the general nutritive process becomes more apparent from an examination of the excretions from the body during the process of starvation combined with an examination of the organs and tissues after death. If an animal be deprived entirely of food, a decline in body weight at once sets in, which continues until about 40 per cent. of the weight has been lost, when death generally ensues. This for the reason that the active tissue cells consume, for the purpose of maintaining the normal temperature of the body, not only their own reserve food material, but that of the less active or storage tissues as well; and, in consequence, there is a progressive diminution in weight.

The phenomena which characterize this non-physiological condition are as follows: Hunger, intense thirst, gastric and intestinal uneasiness and pain, diminished pulse rate and respiration, muscular weakness and emaciation, a lessening in the amount of urine and its constituents, diminished exhalation of carbon-dioxide, an exhalation of a fetid odor from the body, vertigo, stupor, delirium, at times convulsions, a sudden fall in body temperature, and finally death. The duration of life after complete deprivation of food varies from eight to thirteen days, though this period can be prolonged if the animal be supplied with water, this being more essential under the circumstances than the organic materials which can be supplied by the organism itself. The duration of the starvation period will vary in accordance with the previous condition of the animal and the amount of reserved food the body contains. The excretion of urea declines very rapidly during the first two days—a

fact which has been attributed to a rapid consumption of the surplus proteid food. After this period, when the tissues begin to metabolize their own proteid, the excretion remains fairly constant until toward the close, when the amount eliminated falls very rapidly. As proteids contain about 16 per cent. of nitrogen, 1 part of nitrogen equals 6·25 parts of proteid. Hence, for every 1 gramme of nitrogen or 2·14 grammes urea excreted, we may assume that 6·25 grammes of proteid or, according to Voit, 30 grammes of flesh have been metabolized. The daily excretion of urea, therefore, indicates the extent of the proteid metabolism. It will be observed also that there is a steady diminution in the excretion of carbon-dioxide, though this is greatest in the last few days. As fat contains about 76 per cent. of carbon, 1 part of carbon equals 1·31 parts of fat. Hence, for every 1 gramme of carbon or 3·66 grammes carbon-dioxide excreted we may assume that 1·31 grammes of fat have been metabolized. The daily excretion of carbon, therefore, indicates the extent of fat metabolism. The carbohydrates are here left out of consideration, as they constitute only about 1 per cent. of the body weight. It must be borne in mind, however, that in the metabolism of proteid a certain quantity of fat is produced which also undergoes oxidation. The amount of the carbon or the fat that the proteid would give rise to, as previously determined, must therefore be subtracted from that eliminated by the lungs, etc., in order to determine the amount of body fat metabolized. Observations of human beings in the fasting condition show that for a period of ten days there is a daily excretion of about 21 grammes of urea, equivalent to about 70 grammes of proteid. This amount, however, may be reduced to from 50 to 60 per cent. if the individual has a surplus of body fat. Human beings under similar circumstances may lose during the first few days 200 grammes of fat.

The following table shows the excretion of nitrogen and carbon and the calculated amounts of proteid and fat metabolized from an experiment made by Ranke on himself during a fast of 24 hours, beginning 24 hours after the last meal:

Disintegration of Tissue. (Calculated.)			Expenditure.		
	Nitrogen.	Carbon.		Nitrogen.	Carbon.
Proteid, 50 grms....	7·8	26·5	Urea, 17 grms.... Uric acid, 0·2 grm.	7·2	3·4
Fat, 199·6 grms....	0·0	157·5	Carbon-dioxide....	0·0	180·6
	7·8	184·0		7·2	184·0

Coincidently with these losses to the body there is also a gradual loss of inorganic salts, and toward the termination of the period a sudden fall in temperature of several degrees Centigrade, in consequence of the final consumption of all available food, when death ensues, in all probability, from a cessation in the action of the heart.

Post Mortem Appearances.—It has been experimentally determined that animals die when the body weight has declined to about 40 per cent. Post mortem examination shows that the loss of material, though very generally distributed throughout the body, is greatest in organs and tissues least essential to life.

The results of an analysis of the organs and tissues of a cat after a 13 day period of starvation, during which the animal lost 1,017 grammes in weight, are given in the following table, based on data furnished by Voit:

Organ.	Per cent.	Actual Loss of Tissue.
		Grammes.
Adipose tissue	97	267
Spleen	67	6
Liver	54	49
Testes	40	1
Muscles	31	429
Blood	27	37
Kidneys	26	7
Skin and hair	21	89
Lungs	18	3
Intestines	18	21
Pancreas	17	1
Bones	14	55
Heart	3	0
Nervous system	3	1

It will be observed from this table that the adipose tissue suffers the greatest loss, the entire amount disappearing with the exception of a small portion in the posterior part of the orbital cavity and around the kidneys. The muscles, though only losing 31 per cent. of their weight, yet furnish 429 grammes of presumably proteid material, for nutritive purposes. The heart and nervous system experience but slight loss.

Mixed Diet.—The chemical composition of the tissues, taken in connection with their metabolism during starvation, implies that no one article of food is sufficient for tissue repair and heat production; but that all classes of foods, in other words, a mixed diet, are essential to the maintenance of a normal nutrition. Experimental investigation has also conclusively established this fact. Moreover, the amounts of nitrogen and carbon eliminated daily, and the ratio existing between them, indicate the amounts of proteid, fat and carbohydrate which are required to cover the loss.

Metabolism on a Purely Proteid Diet.—Notwithstanding the chemical composition of the proteids and the possibility of their giving rise to both fat and a carbohydrate during their metabolism, it has been found extremely difficult to maintain the normal nutrition for any length of time on a pure proteid or fat-free flesh diet. This, however, has been accomplished with dogs. It was found, however, that, in order to maintain the equilibrium, it was necessary to increase the proteids from two to three times the usual amount. Thus, a dog weighing 30 to 35 kilogrammes required from 1,500 to 1,800 grammes of flesh daily in order to get the requisite amount of carbon to prevent consumption of its own adipose tissue. Under similar circumstances, a human being weighing 70 kilogrammes would require more than 2,000 grammes of lean beef—an amount which, from the nature of the digestive apparatus, it would be practically impossible to digest and assimilate for any length of time. Even the slight habitual excess beyond the amount normally required is imperfectly assimilated and gives rise to the production of nitrogen-holding compounds which, on account of the difficulty with which they are eliminated by the kidneys, accumulate within the body and develop the gouty diathesis, with all its protean manifestations.

Metabolism on a Fat and Carbohydrate Diet.—As nitrogen is an indispensable constituent of the tissues, it is evident that neither fat nor carbohydrates can maintain nutritive equilibrium except for very short periods. On such a diet the tissues consume their own proteids, as shown by the continuous excretion of urea, though the amount is less than during starvation. An excess of fat retards the metabolism of proteids. The same holds true for the carbohydrates.

Thus, in any well arranged dietary there should be a combination of proteids, fats and carbohydrates in amounts sufficient to maintain nutritive equilibrium; in other words, to repair the loss of tissue and to furnish the requisite amount of heat in accordance with work done, as well as with climatic and seasonal variations.

COMPOSITION OF FOODS.

The food principles essential to the maintenance of the nutrition of the body are contained in varying proportions in compound substances termed foods; e. g.: meat, milk, wheat, potatoes, etc. Their nutritive value depends partly on the amounts of their contained food principles and partly on their digestibility. The dietary of civilized man embraces foods derived from both the animal and vegetable worlds. The following table shows the average percentage composition of various kinds of meats:

COMPOSITION OF ANIMAL FOODS.

In 100 Parts.	Beef.	Veal.	Mutton.	Pork.	Fowl.	Fish.	Cow's Milk.	Eggs.
Water	76·25	77·82	75·59	72·57	70·80	79·30	86·87	73·67
Proteid	20·24	19·86	17·11	19·31	22·70	18·30	4·75	12·55
Fat	1·68	0·82	5·47	5·82	4·10	0·70	3·50	12·11
Carbohydrates	0·50	0·80	0·60	0·60	1·20	0·90	4·00	0·55
Salts	1·38	0·70	1·23	1·70	1·20	0·80	0·17	1·13

It will be observed from these analyses that the meats contain from 18 to 20 per cent. of a proteid which belongs in virtue of its chemical relations to the group of globulins. In the living condition this body, known as myosinogen, is in a semi-fluid condition, but shortly after death undergoes coagulation, giving birth to solid myosin and a soluble albumen. There is also present in meat small percentages of other forms of proteid; e. g.: myoalbumen, myoglobulin, paramyosinogen, etc. After being subjected to the cooking process, meats contain the albuminoid body gelatin, a product of the transformation of the proteids of the connective tissue.

The percentage of fat, that contained within the meat substance, is very small except in mutton and pork, where it rises to 5·4 per cent. and 5·8 per cent. respectively. The fat globules in these meats are packed closely between the muscular fibers, and prevent the easy entrance of the digestive fluids, and hence are more difficult of digestion than beef.

The carbohydrates vary from one-half to one per cent., and are represented by glycogen. The principal inorganic salts are potassium phosphate and sodium chloride. All meats should be cooked before eaten. This, when properly done, not only makes the meat more palatable and appetizing from the development of agreeable flavors, but converts the connective tissue, which, in old animals especially, is tough and resisting, into gelatin, thus rendering it more easy of mastication and digestion. At the same time parasitic organisms, such as the tænia or tape worms, trichina spiralis, as well as bacterial growths, which frequently infest the bodies of animals, are destroyed and made harmless.

Milk is the natural food of the young of all mammals, and is usually regarded as typical on account of the ratio existing among its nutritive principles. The analysis given above is that of cow's milk. Examined microscopically, milk is seen to consist of a clear fluid, the milk plasma, holding in suspension an enormous number of small, highly refractive oil globules, which measure on the average about $\frac{1}{3000}$ of an inch in diameter. Each globule is supposed by some observers to be surrounded by a thin albuminous envelope, which enables it to maintain the discrete form. Others deny the existence of such a membrane. The chief proteid constituent of milk, caseinogen, is held in solution by the presence of phosphate of lime. On the addition of acetic acid or sodium chloride up to the point of saturation the caseinogen is precipitated as such and may be collected by appropriate chemic methods. When taken into the stomach, caseinogen is coagulated; that is, it is separated into casein or tyrein and a small quantity of a new soluble proteid. This change is brought about by the presence in the gastric juice of a special ferment known as rennin.

The fat of milk is more or less solid at ordinary temperatures. It is a composition of olein, palmitin, and stearin, with a small quantity of butyrin and caproin. When milk is allowed to stand for some time, the fat globules rise to the surface and form a thick layer known as cream. When subjected to the churning process, the fat globules run together and form a coherent mass—butter.

Lactose is the particular form of sugar found in milk. In the presence of the bacillus acidi lactici, the lactose is decomposed into lactic acid and carbon-dioxide, the former of which not only imparts a sour taste to the milk, but causes a precipitation of the caseinogen. The chief salt found in milk is phosphate of lime, and is the chief source of this agent in the formation of bones.

Eggs are also to be regarded as complete natural foods, inasmuch as they contain all the necessary food principles. The analysis given in the above table represents the composition of the entire egg. The white of the egg contains 12 per cent. of proteid and 2 per cent. of fat. The yolk, however, contains 15 per cent. of proteid and 30 per cent. of fat.

COMPOSITION OF CEREAL FOODS.

In 100 Parts.	Wheat.	Rye.	Barley.	Oats.	Corn.	Rice.	Buckwheat
Water	13·56	12·65	13·77	12·37	13·10	13·12	12·62
Proteid	12·35	12·55	11·14	10·41	9·85	7·88	10·02
Fat	1·75	1·97	2·16	5·23	4·57	0·85	2·24
Carbohydrate	67·90	67·95	64·93	57·78	68·42	76·55	64·43
Cellulose	2·63	3·00	5·31	11·19	2·50	0·55	8·67
Salts	1·81	1·88	2·69	3·02	1·56	1·05	2·02

That the cereals are most important and useful articles of diet is evident from their composition, consisting, as they do, of proteids and carbohydrates in large proportion. Owing to the cellulose or woody fiber which envelops and penetrates the grain, they are somewhat difficult of digestion. A section of a grain of wheat shows the external cellulose envelope, the bran or husk, beneath which is a layer of large cells containing the chief proteid—the gluten. The interior of the grain consists of small cavities, the walls of which are formed of cellulose and which contain the granules of starch, fat, small quantities of proteid, and inorganic salts. All other cereals have a similar structure.

In the preparation of white flour from wheat it is customary to remove the husk, a process which involves the removal also of a portion, if not all, the gluten cells, so that such flour contains less nitrogenized material than the original grain. It is possible, however, in the milling of wheat, to remove only the husk and retain the gluten in the flour, as is the case with whole wheat flour.

Bread is an artificially prepared food made either of wheat or rye. Owing to the fact that the proteids of the other cereals do not possess the same adhesive properties when kneaded with water, they cannot be used for bread-making purposes. In the making of bread, the flour is kneaded with water until a glutinous mass—dough—is formed. During this process, salt, sugar, and yeast are added. It is then placed in a temperature of about 100° F. In the presence of heat and moisture the natural ferment of the flour—diastase—converts a portion of the starch into sugar, which in turn is split up into carbon-dioxide gas and alcohol by the yeast plant. The bubbles of carbon-dioxide, becoming entangled in the dough, cause it to swell or rise and subsequently give the porous or spongy character to the bread. When baked at a temperature of 400° F., the alcohol is driven off, yeast cells and other organisms are destroyed; the starch, particularly that on the surface, is dextrinized. Thus prepared, white bread consists of water, 32 per cent.; proteid, 8·8 per cent.; fat, 1·7 per cent.; carbohydrate, 56·3 per cent.; salts, 0·9 per cent. The principal salts are potassium and magnesium phosphate. Whole wheat bread consists of water, 40 per cent.; proteid, 12·2 per cent.; fat, 1·2 per cent.; carbohydrate, 43·5 per cent.; salts, 1·3 per cent.; cellulose, 1·8 per cent.

COMPOSITION OF VEGETABLE FOODS.

In 100 parts.	Beans	Peas.	Potatoes.	Beets.	Turnips.	Tomatoes.	Asparagus.	Cabbage.
Water	13·74	14·99	75·47	82·20	89·42	96·30	93·75	89·97
Proteid	23·21	22·85	1·95	1·80	1·35	0·90	1·79	1·89
Fat	2·14	1·79	0·15	0·30	0·18	0·50	0·25	0·20
Carbohydrates	53·67	52·36	20·69	13·00	7·36	2·80	2·63	4·87
Cellulose	3·69	5·43	0·76	......	0·94	......	1·04	1·84
Salts	3·55	2·58	0·98	1·60	0·75	0·4	0·54	1·23

The vegetable foods, as a class, vary considerably in nutritive value and digestibility, the latter depending on the amount of cellulose, they contain. A section of a vegetable shows not only the presence of an external envelope, but also an inner framework which penetrates the vegetable in all directions. The nutritive principles are contained in small cavities, the walls of which are formed by the framework. Nearly all vegetables require cooking before being eaten. When subjected to heat and moisture, not only is the texture of the vegetable softened and disintegrated, but the starch grains are hydrated and partially converted into dextrine and sugar. At the same time various savory substances are set free, which make the food more palatable.

Beans and peas contain large quantities of a proteid, legumen, and starch, and hence are especially valuable as nutritive foods. The presence of the cellulose envelope, especially in old beans and peas, combined with rather a dense texture, renders them somewhat difficult of digestion. Potatoes, though largely employed as foods, are extremely poor in proteids, 2 per cent., and carbohydrates 20 per cent. When sufficiently cooked they are easily digested, owing to the small amount of cellulose they contain.

The green vegetables, e. g., lettuce, spinach, tomatoes, asparagus, onions, etc., though containing food principles in small amounts, are, nevertheless, valuable adjuncts to the dietary, for the reason that they contain inorganic as well as organic salts, which appear to be necessary to the maintenance of the normal nutrition. The want of green vegetables has been supposed to be the cause of scurvy.

Ripe fruits, grapes, cherries, apples, pears, peaches, strawberries, lemons, oranges, etc., though consumed largely, possess but little nutritive value. They consist largely of water, 75 to 85 per cent., proteids a trace, sugar from 5 to 13 per cent., organic acids, citric, malic, tartaric, pectose, and various inorganic salts. The disposition of the vegetable acids in the economy and the role they play in the nutrition has not been satisfactorily determined.

Relative Value of Animal and Vegetable Foods.—Though both animal and vegetable foods contain the different classes of food principles, it is not a matter of entire indifference as to which are consumed. It has been found by experiment that animal proteids are more easily and completely digested and absorbed than vegetable proteids; that cellulose is not only highly indigestible, but by its presence in large quantities retards the digestive process and impairs the act-

ivity of the entire digestive mechanism. The following table shows the relative digestibility of the two classes of foods :

Weight of Food.	Vegetable.		Animal.	
	Digested.	Undigested.	Digested.	Undigested.
Of 100 parts of solids...	75·5	24·5	89·9	11·1
Of 100 parts of proteid..	46·6	53·4	81·2	18·8
Of 100 parts of fats or carbohydrates... ..	90·3	9·7	96·9	3·1

Hoffman.

Construction of Dietaries.—Inasmuch as neither the animal nor vegetable foods contain the food principles in proper quantities and proportions, the instinctive choice of mankind has led to a combination of the two classes of foods. From the analyses tabulated above it becomes comparatively easy to construct a suitable dietary, composed of different articles of food, in which the food principles shall bear the proper ratio to each other—a ratio based on the total quantity of nitrogen (15 to 20 grammes) and carbon (225 to 300 grammes) eliminated from the body daily.

It is only necessary, therefore, to combine two or more foods, the composition of which is known, in quantities sufficient to furnish the requisite amount of nitrogen and carbon or their equivalents in proteid, fat, and carbohydrates. As illustrations of such combinations the following examples are given :

Foods.			Food Principles		N.	C.
Meat.....	250 grms.,	8·8 oz.	Proteid	100 grms.	15	50
Bread.........	400 grms.,	14·2 oz.	Fat............	100 grms	..	75
Fat	100 grms.,	3·5 oz.	Carbohydrates..	250 grms.	..	100
Sugar.........	70 grms.,	2·5 oz.				
					15	225

(Ranke.)

Foods.			N.	C.
Meat..................	225 grms.,	½ lb.	7·5 grms.	34 grms.
Bread.................	450 grms.,	1 lb.	5·5 grms.	117 grms.
Fats..................	113 grms.,	¼ lb.	.. ..	84 grms.
Potatoes..............	450 grms.,	1 lb.	1·8 grms.	45 grms.
Milk..................	225 grms ,	½ pint	1·7 grms.	20 grms.
Eggs..................	113 grms.,	¼ lb.	2·0 grms.	15 grms.
Cheese................	56 grms.,	⅛ lb.	3·0 grms.	20 grms.
			21·0	335

(Waller.)

DAILY RATION OF THE UNITED STATES SOLDIER.

Fresh beef	20 oz.
or pork	12 oz.
or bacon	12 oz.
Flour	18 oz.
or soft bread	18 oz.
or hard bread	16 oz.
Potatoes	16 oz.
or { potatoes 11⅕ / tomatoes 4⅘ }	16 oz.
Beans or peas	2·4 oz.
Rice or hominy	1·6 oz
Coffee	1·6 oz.
Sugar	2·00 oz.
Vinegar	0·32 gill
Salt	0·60 gill

INVISIBLE AND SYMPATHETIC INKS.

By J. RUTHERFORD HILL.

SO-CALLED invisible and sympathetic inks are well known, and there are many formulæ for their production. They have been used for secret correspondence, but are perhaps of more interest to the conjurer or the romancist than to the prosaic disciple of Galen. And yet the latter is not infrequently applied to by the conjurer, either professional or amateur. Such was my lot on a recent occasion. An invisible or a sympathetic ink was required that would become visible on exposure to the fumes of either chloroform, ether, or ammonia. A reference to the usual authorities gave no practical result, and the case seemed rather hopeless; but it occurred to me that by using a solution of mercurous nitrate and exposing the writing to the fumes of ammonia, a precipitate of black mercurous nitrate would be formed and give the desired result. On writing with such a solution, by means of a quill, on ordinary white paper, the writing, when dry, is invisible. A small quantity of strong solution of ammonia is placed in the bottom of a large cylindrical glass jar, which thus becomes filled with ammonia gas in a suitably moist condition. On placing the paper with the invisible writing inside the jar for a few seconds and then withdrawing it, it will be found that the writing comes out in a very distinct black.

This is an invisible ink, but when once developed it remains. A sympathetic ink, on the other hand, is one that becomes visible and then vanishes again as required. To meet this requirement it occurred to me to try a fairly strong solution of phenol-phthalein. Writing with such a solution on ordinary white paper is quite invisible when dry, but when placed for a few seconds in the jar above mentioned the writing becomes of a beautiful pink color, which fades as the ammonia evaporates. By breathing upon the paper the color disappears almost immediately. By a little thought many other devices of a curious and interesting kind might be discovered, and perhaps the addition of the foregoing to the ideas already in existence may be found useful by those who are called upon to cater for the multifarious demands for something new, mysterious, and entertaining.—Pharmaceutical Journal.

It will be glad news to tourists to learn that the sewage problem has made its appearance at Naples. The disposal of the town refuse has led to a lengthy discussion at the meetings of the Reale Instituto d'Incoraggiamento di Napoli, and the publication of a number of papers in their large annual volume of Atti. The subject is introduced by Prof. Paolo Boubée, who seems to rather favor treatment by the Arnold-Le Blanc system, or the use of destructors; though it would appear that the refuse of the Neapolitan streets is too wet, and also too poor in carbon, to burn without the additional consumption of coal. At present the street sweepings are taken and deposited some distance outside the city, and the accumulations ultimately used as manure; but the effluvia arising from so large a mass of putrefying matter have become prejudicial to health. It is suggested that the problem might be best solved by a series of experiments on the different alternative methods of disposal.

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